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OUR HOME RAILWAYS

HOW THEY BEGAN AND HOW THEY ARE WORKED

BY

W. J. GORDON

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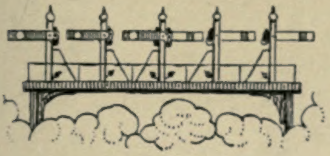

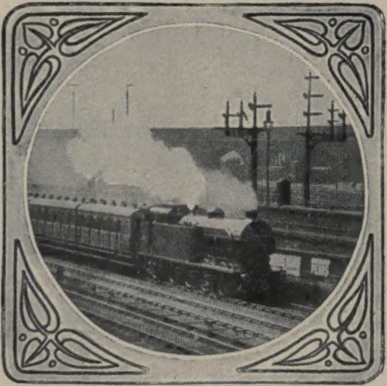

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OUR HOME RAILWAYS

HOW THEY BEGAN AND
HOW THEY ARE WORKED

Econ
G.

BY

W. J. GORDON

AUTHOR OF "EVERYDAY LIFE ON THE RAILROAD"
"FOUNDRY, FORGE, AND FACTORY" ETC. ETC.

WITH 36 ORIGINAL COLOURED PLATES
BY W. J. STOKOE
AND
300 ILLUSTRATIONS FROM PHOTOGRAPHS

VOL. II

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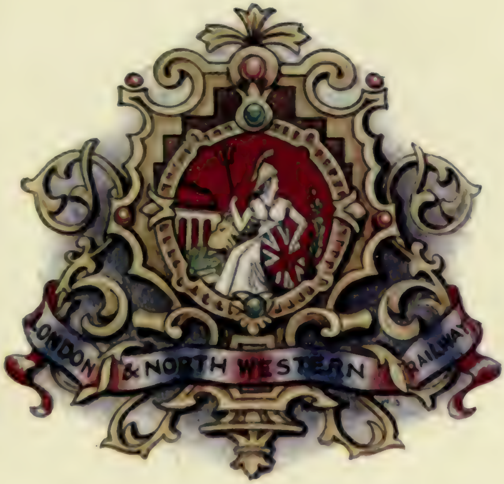
THE LONDON & NORTH WESTERN



COAT-OF-ARMS

The Entrance to Euston Station.

THE LONDON & NORTH WESTERN

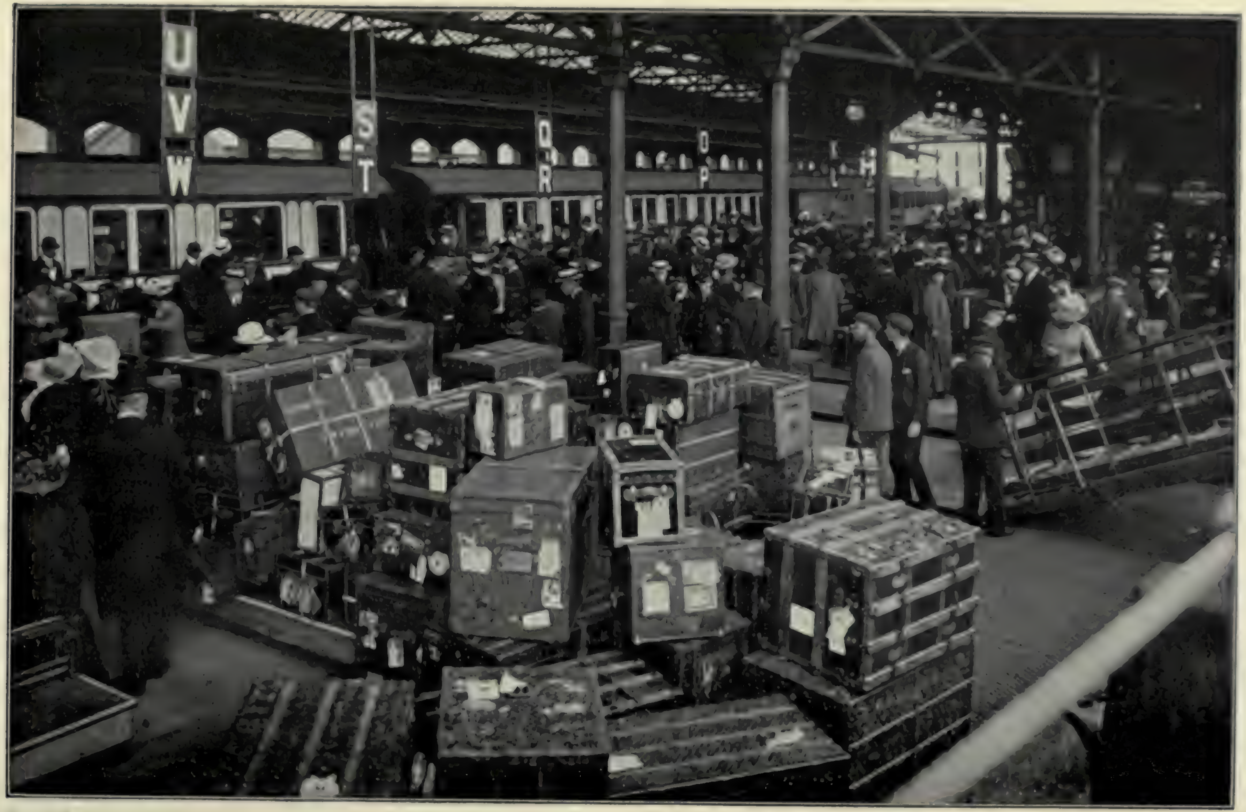
THE North Western has adopted Britannia as its arms, and a more representative British institution it would be difficult to find. By its natural growth from the main stem of the London & Birmingham, and by the gradual absorption of over a hundred other railway companies, it has attained a length of two thousand miles. In a year it carries over 77 million passengers and 55 million tons of minerals and merchandise, and its revenue is £16,000,000, that is £43,600 a day.

The story of the North Western is always taken to begin with the Liverpool & Manchester, as it really does, but its claim to that ancestor is by absorption, and if age is to date from that of an amalgamated company it is entitled to a longer pedigree. Six miles north-east of Merthyr Tydvil is Sirhowy, to which from the Monmouthshire Canal—

entering the Usk a short distance above Newport—there ran a tramroad 28 miles long for the carriage of iron and coal, the iron from the Sirhowy and Tredegar works. This was a similar arrangement to that which put Penydaren works —which also belonged to the Homfrays—in communication with the Glamorgan Canal, but it was more recent, the Act not being obtained until 1802; and, as far as Trevill, it was a real railroad laid with edge rails. On it in 1829, the year before the opening of the Liverpool & Manchester, was placed the sixteenth engine built by the Stephensons at the Forth Street works, the Rocket being the nineteenth and the Invicta the twentieth. This was the long-lived Tredegar locomotive which was at work when the North Western took over the line in 1860, and, after working for over fifty years, was withdrawn in 1882. It was a 6-coupled goods engine, originally not unlike the Experiment of 1826 (No. 6 of the Stockton & Darlington), which was the ninth engine built by the Stephensons; but it was more powerful, the cylinders being 10½ in. by 20 in., and the coupled wheels 42 in. in diameter, while the cylinders of the older engine—which seems to have been the first with 6-coupled wheels—were 9 in. by 24 in. and the wheels 48 in.

So far as the project was concerned the Liverpool & Manchester was, however, older than the Sirhowy, for in 1797 William Jessop proposed a tramroad for horses between the two places and surveyed a route which was not approved of. In 1798 Benjamin Outram made a survey of another route, merely Jessop's modified, which met with the same fate, the only result being that the canal people, in fear for their monopoly, became a little more reasonable.

For more than twenty years the canal continued to be the only means of communication, except, of course, the road; and as business increased in the towns so did the canal business increase, until it became too great to be properly dealt with. Evidently something had to be done, and what more natural



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ARRIVAL OF A WHITE STAR LINER AT HOLYHEAD—SPECIAL TRAIN PREPARING TO LEAVE FOR LONDON

than that the something should be the making of one of those railroads that people were beginning to talk about?

It was early in 1821 that Joseph Sandars, one of the leading Liverpool merchants, met William James the land-agent, who happened to be in the neighbourhood on a survey. James had laid several short tramroads on private estates in Gloucestershire and elsewhere, and was interested in their introduction. He found a willing listener in Sandars, who had recollections of the Jessop and Outram plans; and the meeting resulted in James being allowed to begin, partly at his own expense, a survey of a suitable route for the information of a committee formed by Sandars. While that survey was in progress, under difficulties reminding one of a scouting expedition through an enemy's country, James went to Killingworth to look at George Stephenson's engines, and from that time onward he became an enthusiastic advocate of the locomotive. In fact he became a partner with a fourth share in Stephenson & Losh's patent, and started "travelling" for the firm, his "line" being what he called "engine-railroads."

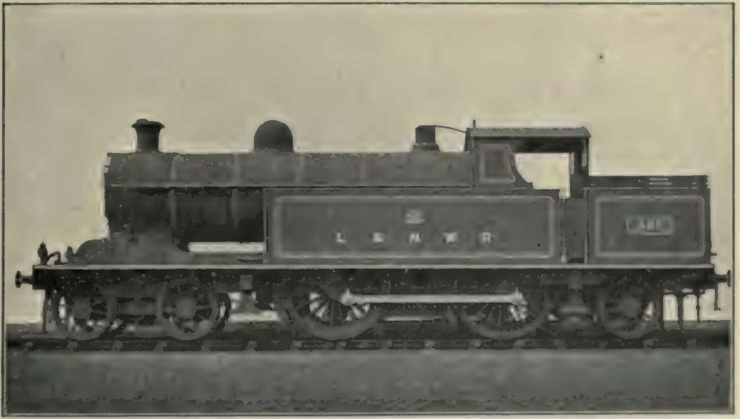
His survey proving too incomplete and sketchy for working purposes, a new survey was made during the next year in which he was assisted by Robert Stephenson, and it was while this was in hand that Chat Moss was first crossed, or rather attempted to be crossed, for James nearly disappeared by sinking into the swamp, and further advance was postponed owing to the want of a firm footing for the theodolite. For this and other reasons the plans were not ready until too late for the next parliamentary session, and there were negotiations and a Public Declaration and a public meeting, and futile attempts at an understanding with the canal company.

Then followed the appointment of George Stephenson as engineer, another survey by him and T. O. Blackett, and the issue of the first prospectus on the 29th of October 1824, which laid stress on the probable profit to be made out of the carriage of merchandise, and only cautiously referred to the conveyance of passengers; and in 1825 the first Bill was introduced. It was opposed by the canal company, and every other local vested interest, with a display of ignorance and venom on the part of the counsel for the opponents—Alderson, for instance—that makes one wonder of what sort of men Barons of the Exchequer were made; and it was thrown out in the Commons. Then another survey was undertaken—the sixth—not by George Stephenson, but by the Rennies and Vignoles, who laid out a line avoiding parks and game preserves while the canal company was arranged with; and in 1826 the Act was obtained, "for making and maintaining a Railway or Tramroad from the town of Liverpool to the town of Manchester."

George Rennie expected to be chief engineer, and felt so sure of the post that he would only accept it on his own conditions, one of which was that he should appoint the resident engineer, which meant that he would get rid of George Stephenson. The directors, quite appreciating the position, appointed Stephenson as chief, and the Rennies had no more to do with the Liverpool & Manchester. Stephenson appointed three residents, all his pupils, Joseph Locke, William Allcard, and John Dixon; and to Dixon was given the Chat Moss section, where he had the difficult

No. 513—"Precursor" Type.

job of floating a railroad for the first time over a peat bog—four miles of it, twenty or thirty feet deep, mostly sphagnum living and dead, a mass of plant remains that thickened and thinned with every change of weather. How it was done, with hurdles and tree branches and hedge cuttings and dry turf and trusses of heather, and tar barrels as drain pipes, and gravel as ballast, until every 67 cubic ft. of raw moss became 27 cubic ft. of embankment, every one knows, though every one does not remember that the whole problem was new. There was also Parr Moss to be crossed for a mile and a half by dumping down into it the clay, stone, and shale from a neighbouring cutting, until it sank to the bottom and formed a road that was level with the marsh around. Then there were cuttings to be made—Olive Mount, for instance—and tunnels at the Liverpool end, and bridges, 63 of them, and viaducts, quite trifles nowadays when the North Western has 120 tunnels, over 7000 bridges, and nearly 400 viaducts on it, but then a very different matter, for the Liverpool & Manchester was the great experimental railway.

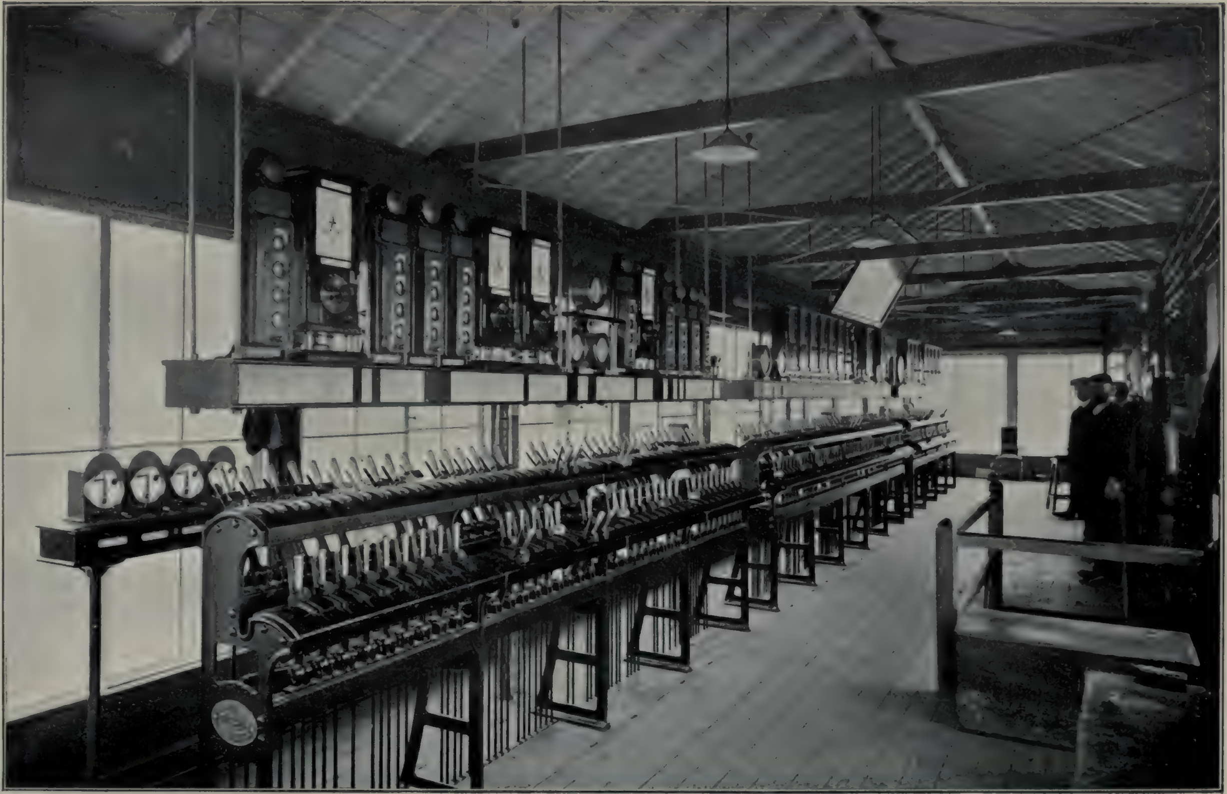


No. 528—A powerful Tank Engine for Passenger Traffic.

In making the road one of Stephenson's locomotives, the Twin Sisters (with two chimneys), in 1827, and another, the Lancashire Witch, in 1828, began work hauling the wagons of stuff from the two great cuttings to be used in forming the embankments, the first engines of a permanent way department; but, notwithstanding this and the Stockton & Darlington, some of the directors refused to believe that locomotives could deal with the general traffic, and for a time held out in favour of rope traction all the way. Finally, however, the rope with stationary engines was adopted for the Liverpool and Sutton inclines (which had been introduced with the Rennie survey and were admitted to be too steep for any existing locomotive to ascend with a load), and a prize of £500 was offered for the best locomotive to work the rest of the line.

The course was a level stretch on the Manchester side of Rainhill Bridge. It was 1¾ miles in length, of which 220 yards at each end were allowed for starting and stopping. Ten double trips had to be made along the 1½ mile course, representing a journey from Liverpool to Manchester; then water and fuel were to be taken in, as at that terminus, and another series of ten double trips performed to represent the return journey. The minimum speed was to average ten miles an hour; the load to be three times the weight of the engine; the boiler pressure not to exceed 50 lb. per square inch, with two safety valves, one of which to be out of the control of the driver; the height of the engine to be no more than 15 ft. from the rails to the top of the chimney; and the weight in working order not to exceed 6 tons, engines over 4½ tons to have six wheels. A whole day was devoted to the trial of each engine. The judges were J. U. Rastrick, who built the Agenoria, and afterwards made most of the Brighton line; Nicholas Wood, who invented the railway carriage and wrote much about railways; and John Kennedy, the inventor of the jack-frame and many other items in cotton-spinning machinery.

There were four entries,—Robert Stephenson's Rocket,



AN UP-TO-DATE SIGNAL CABIN—ELECTRIC SIGNALLING APPARATUS, SOUTH JUNCTION, CREWE

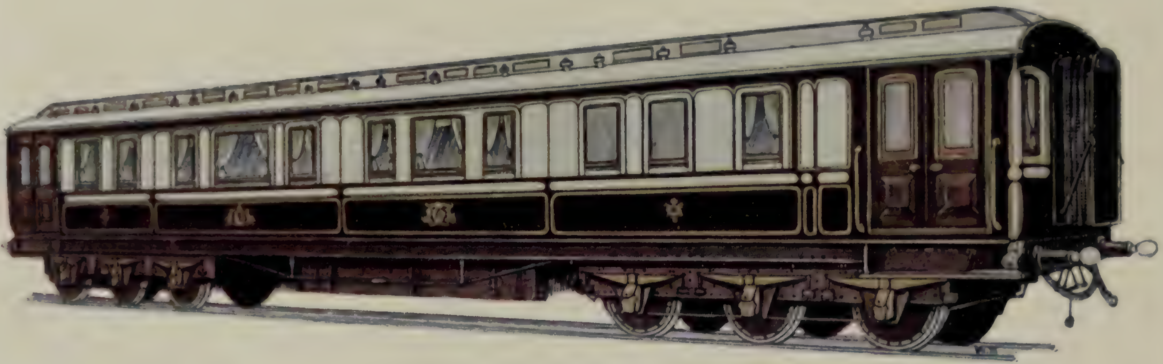
Braithwaite & Ericsson's Novelty, Timothy Hackworth's Sanspareil, and Timothy Burstall's Perseverance; but Thomas Shaw Brandreth, a director of the company who resigned just before the completion of the line, was allowed to give an exhibition of his Cyclopede, in which the weight of a horse was utilised on a moving platform so that the animal carried itself at a rate of six miles an hour.

The Perseverance was a road-motor engine with flanged wheels and a two-speed gear. The boiler had a steam-jacket, and there was a steam-blast, the pipe for the exhaust steam passing through the water-tank, for warming purposes, and returning along the top of the boiler to enter the chimney and deliver the blast at the junction of the barrel. The cylinders were two in number, and were vertical and placed between the driving wheels, the side rods from them not working a crank but toothed wheels, as shown in Burstall's specification (No. 5405); but he could not get along with the load at more than five miles an hour, and gave up the contest as hopeless.

What is left of the Novelty is at South Kensington. She was invented and built all within seven weeks, and was a tank engine of peculiar construction. Her draught was obtained from a pair of bellows and not from exhaust steam; she just exceeded 16 miles an hour during four trips, and her boiler joints gave way so that she had to be withdrawn. The most interesting thing about her is that she was driven by Charles Fox, one of Ericsson's pupils, who from the day of her trial became a friend of Robert Stephenson's and was one of his assistants on the London & Birmingham, being the man who carried out the extension of that line from Camden to Euston. He built the Great Exhibition of 1851, and he, and not Paxton, was the real designer of that building; and he designed and built the Crystal Palace at Sydenham, which is not the same building as that of the exhibition, although the materials of the flat-roofed structure were used up in it.

There were only two engines to be taken seriously in the competition, the Rocket and the Sanspareil, one designed by Robert Stephenson, the other by Hackworth, the locomotive superintendent of the Stockton & Darlington. Both engines are now at South Kensington. The Rocket was built complete at the Forth Street works, where the cylinders of the Sanspareil were also made, the Shildon shops being unequal to the task, just as they were unequal to producing the boiler, which was made by John Birkinshaw, of the rolled rail, at Bedlington. This boiler was a cylindrical shell with one flat end and the other dished, and it had an internal return flue projecting on the fire-grate side and enclosed in a water-jacket; the two cylinders, 7 in. by 18 in., were vertical, and worked downwards on the hind wheels, which were coupled to the leaders, the wheels being 54 in.; the blast-pipe from the right-hand cylinder was brought across to join with that from the left-hand cylinder and enter the tall chimney half-way from the top, and it was 3 in. in diameter; the grate area was 10 sq. ft., the heating surface 90 sq. ft.; and the engine weighed in working order 4¾ tons.

This was a quarter of a ton overweight for a 4-wheeler, and there should have been six wheels, but the judges allowed it to be tried and it did very well. On one trip it went at 17½ miles an hour, and it had run 27½ miles at an average speed of nearly 14 miles an hour when it broke down. "The metal forming the partition between the bore of the cylinder and the port-way or steam-pipe along the cylinder side had been cast and bored so thin in one part as to leave less than a sixteenth of an inch of thickness, and the engine had no sooner begun working than the cylinder burst and the race had to be run with one perfect cylinder only, while the fracture of the other one opened at every stroke a direct communication between the boiler and the chimney"—that is Hackworth's story, the usual explanation being that the feed-pump broke. That a



THE LONDON & NORTH WESTERN RAILWAY

CAR USED BY HIS MAJESTY THE KING

Extreme length, 69′ 6″ Extreme width, 9′ 6″ Extreme height from rail, 12′ 7½″ Carried on two
Distance between centres of bogies, 43′ 6″ Total wheel base, 55′ 0′ 6-wheel bogies.
Balcony entrance. Smoking compt. Day compt. Sleeping compt. Dressing-room. Side corridor.
Attendant's vestibule compartment. Steam heated. Electric lighting. Lavatories.

faulty cylinder should cause the trouble was not unlikely, for six had been cast before two seemingly perfect ones had been obtained, the fifth having been found defective after leaving Shildon, and the sixth having been fitted at Liverpool.

Thus it came about that the great competition was won by the only survivor, the only engine that complied with all the conditions. On the 8th of October 1829 the Rocket ran the full distance out and home at an average speed of 13·8 miles an hour, the fastest journey being at the rate of 24·1 miles an hour. The boiler was cylindrical, 40 in. broad and 72 in. long; the cylinders, at an angle of 37 degrees, were—as in the new model at South Kensington—8 in. by 17 in. The firebox, of copper, was not unlike a letter-box in shape, and was bolted on to the end of the barrel; at the top, back, and sides it had a 2½-in. water-space, and in front it had a firebrick lining, the gases from it passing through the tubes into a cavity at the base of the chimney which did duty as a smokebox. There were 25 copper tubes 3 in. in diameter placed in the lower half of the boiler; the heating surface was 138 sq. ft., and the grate area 6 sq. ft.; two 2½-in. pipes connected the water-space of the firebox with that of the barrel, and two similar pipes connected the top of the firebox with the steam-space. The working pressure was 50 lb., and, besides the two safety valves, there was a slender mercurial gauge as tall as the chimney, running up the left-hand side of it, indicating steam pressures between 45 lb. and 60 lb. There were two blast-pipes, one from each cylinder, carried along the top of the barrel, entering on each side of the chimney and ending in a blast-nozzle 1½ in. in diameter; the driving wheels were of wood, with cast-iron bosses and iron tyres, and their diameter was 56½ in., that of the cast-iron trailers being 34 in.; the wheel base was 7 ft. 2 in.; the engine weighed 4 tons 5 cwt. in working order, the tender 3 tons 4 cwt., the total weight being 7 tons 9 cwt., but in the trials the weight of the tender was taken as part of the load. On the occasion of the contest the

Rocket, according to Vignoles, who was there, was painted yellow lined with black, her chimney being white, while the Novelty was painted a deep blue, but according to the Kensington model she was lagged with wooden battens, and, with her polished oak driving-wheels, black ironwork, and bright copper work, looked as smart as a modern express engine. Her driver was Mark Wakefield. The prize money is said to have been divided between Robert Stephenson, who designed the engine, and Henry Booth, the secretary of the company, who suggested the copper tubes in the boiler and was also the inventor of the coupling-screw.

Needless to say, the Liverpool & Manchester directors talked no more of ropes or horses, and when the line opened on the 15th of September 1830 there were eight engines to take part in the ceremony—on the Northumbrian was George Stephenson, on the Phœnix Robert Stephenson, on the North Star Robert Stephenson (George's brother), on the Rocket Joseph Locke, who managed to run over Mr. Huskisson, on the Dart Thomas Gooch (George Stephenson's very excellent secretary), on the Comet William Allcard (resident engineer at the Manchester end), on the Arrow Frederick Swanwick, and on the Meteor Anthony Harding. Four of these engines, the Meteor, Comet, Arrow, and Dart, had cylinders 10 in. by 16 in., the three last that were built, the Phœnix, North Star, and Northumbrian, had them 11 in. by 16 in. The cylinders were all outside, the first inside cylinder engine being the Planet, which was put on the rail soon after the opening, and on the 4th of December hauled the first goods train from Liverpool to Manchester.

The North Western includes four other railways whose Acts were obtained before that for the Liverpool & Manchester. These are part of the Llanvihangel, a mineral line near Abergavenny, which had its Act in 1811, the year in which there were 180 miles of iron tramroads at work in South Wales; the Nantile, a slate line at Carnarvon, authorised in 1825 and opened in 1828; the Cromford &

High Peak, authorised in 1825 and opened in 1830, a line 33 miles long rising 990 ft. from the Cromford Canal and worked by ropes; and the Bolton & Leigh, authorised in 1825 and opened in 1831, on which the Sanspareil worked for fourteen years. In 1829 an Act was obtained for a branch from the Liverpool & Manchester at Newton to Warrington, which was opened in 1833; and in that year, after much opposition, the Act was passed for the Grand Junction Railway from Warrington to Birmingham through Crewe to join the proposed London & Birmingham. Of this line Joseph Locke was the engineer.

A London and North Western Guard.

When George Stephenson was building the Sankey Viaduct he went to Stourton quarry in search of stone, and there met Thomas Brassey to whom it belonged. Brassey was the agent for the large estate on which Birkenhead now stands, and had taken part in the survey of Telford's famous road from Shrewsbury to Holyhead. He was not a navvy, as some people suppose, but a gentleman of the old school, and the best descended of all the railwaymen. His family had lived at Bulkeley Old Hall for six centuries before they moved in 1663 to their other property at Buerton, where Thomas was born in 1805. The Liverpool & Manchester Company were making their own line, as all the other companies had done up to then, the only thing in the nature of a contract being the usual piece-work in a small way; and the idea had occurred to Stephenson that as a chief engineer had quite enough to do without supervising all these numerous details there was an opening in railway making for a new trade, that of contracting on a large scale for sections of the line by responsible men of sufficient means. In talking to Brassey he thought he had found the very man for such a task, as indeed he had, and so he opened his mind to him and enlarged on the possibilities of such a career.

Joseph Locke agreed with his chief that the piece-work business was unsuitable for such large ventures, and when planning the Grand Junction he cut the line up into sections and introduced the tender system. Old George went to see Brassey, and suggested that he should put in a tender for some of the works and get his bankers at Chester to finance him. The bankers at once appreciated the idea, and Brassey sent in his first tender, that for the Dutton Viaduct, which was too high, and then his second, for the Penkridge Viaduct, which was accepted. This brought him into contact with Locke, and henceforth the two were inseparable. Wherever Locke was engineer and Brassey was contractor the work was thoroughly well done and finished to the minute—and there were no extras. Brassey was the navvy king;

he kept his engagements, he made money, and he was idolised by every one he employed—and sometimes he had 80,000 men under him, for the railways he made extended for 6667 miles, including the ten with which he began on the Grand Junction.

The Grand Junction was for a time our most important railway. Within a few years it had absorbed the Warrington & Newton, the Liverpool & Manchester, the Bolton & Leigh, the Crewe & Chester, and the North Union from Newton to Preston, and it had made arrangements with the Lancaster & Preston and the Lancaster & Carlisle when in 1846 it and the Manchester & Birmingham, which had only got as far south as Crewe, were amalgamated with the London & Birmingham to become the North Western, with a through route from London to Carlisle.

The Scotch Express travelling at high speed.

The London & Birmingham, like the Grand Junction, obtained its Act in 1833. The opposition was so great and virulent—there were 112 miles to be fought over—that the Bill failed to pass at the first attempt, being thrown out by the House of Lords, but during the winter of 1832 the country opponents were "conciliated," as it was called, that is to say half a million of money was shared amongst them to be debited to the company's capital account, and the towns were silenced by keeping the line at a distance from them so that their inhabitants might have a long, healthy walk to the nearest station.

The Rennies, as in so many cases, had already planned a route, and the promoters had at first thought of employing them and George Stephenson as joint engineers; but to this the Stephensons would not agree, and again the decision was against the Londoners. But the Rennies went on with their scheme, and there were two projects before Parliament, the earlier of which was rejected. The line as made was surveyed by Robert Stephenson, who walked the distance no less than twenty times. It was made by contract, and very few of the contractors profited by it. The works were on a much larger scale than those of the Liverpool & Manchester, and included the three great cuttings at Tring, Denbigh Hall, and Blisworth, and the eight tunnels, of which Primrose Hill and Kilsby gave immense trouble.

At Primrose Hill the pressure of the clay swollen by the moisture of the atmosphere squeezed the mortar through from the joints and made the face of the brickwork fly off in chips, until the hardest bricks obtainable were laid in Roman cement, which by setting before the pressure became great enough to force the bricks into contact formed a sound arch 27 in. thick. At Kilsby the trial borings missed a water-laden pocket of sand and gravel in the lias shale, and the second shaft put down struck into it. Steam pumps had to be installed, and by pumping for eight months continuously at 1800 gallons a minute, clearing out as much water as the Thames holds at high tide between London Bridge and Woolwich, the 1300 men at work night and day managed to proceed with the tunnel, in which

13,000,000 bricks were used, the cost being £300,000 instead of the contract price of £99,000.

By the 4th of June 1838 the line had been opened from London to Denbigh Hall, the name of one of the coaching inns, and from Rugby to Birmingham, the gap of 35 miles being worked by coaches ; on the 17th of the following September it was opened throughout under its first manager, Ashlin Baxter, whose first clerk was David Stevenson, and before many months had elapsed Denbigh Hall had become Bletchley. The line ascended 308 ft., the gradients changing forty-four times, 54 miles of it being uphill and 44 downhill, only 14 miles being level. There was a gradient of about 1 in 70 from Chalk Farm (Camden) down to Euston, and when the line was completed this was worked by a rope and stationary engines. Coming up out of Euston a man stood on the front of the train with a thin short rope, called a messenger, with which he took a hitch

Picking up water in speed, near Pinner.

round the moving cable and a double turn round the coupling hook, and as he passed Camden he let go. It was for signalling on this rope-line between Camden and Euston that the electric telegraph of Cooke and Wheatstone was first used on the 25th July 1837, but not adopted, as the plan of a whistle worked by an air-tight pipe leading into a tub of water at each end, the mouth of the pipe being above the water level and covered by a bell-shaped receiver dipping in the water, was found to answer satisfactorily. The Doric arch at Euston Grove—as the station was first named—was designed by Philip Hardwick, and finished in 1839. It is built of Bramley Fall stone, and is 72 ft. high, and it cost £35,000, which many thought was a waste of money, particularly after the two hotels were connected by the buildings over the roadway. The first Birmingham station was at Curzon Street, and it was almost as classical as Euston in external appearance.

The year the London & Birmingham was opened George Stephenson made the first survey for the line from Chester to Holyhead, but little was done for four or five years, and the Act was not obtained until 1844. The engineer was Robert Stephenson, and he it was who built the bridge over the Menai Straits, the greatest engineering achievement up to then. Here was a strait 365 yards across, with the tide rising 20 ft. in it, and the Britannia rock in the middle which afterwards gave its name to the bridge. The intention was to have two cast-iron arches of 350-ft. span, but the Admiralty objected, and insisted that the navigation must not be interfered with for a single day, and that not even a scaffold could be allowed while the bridge was under construction.

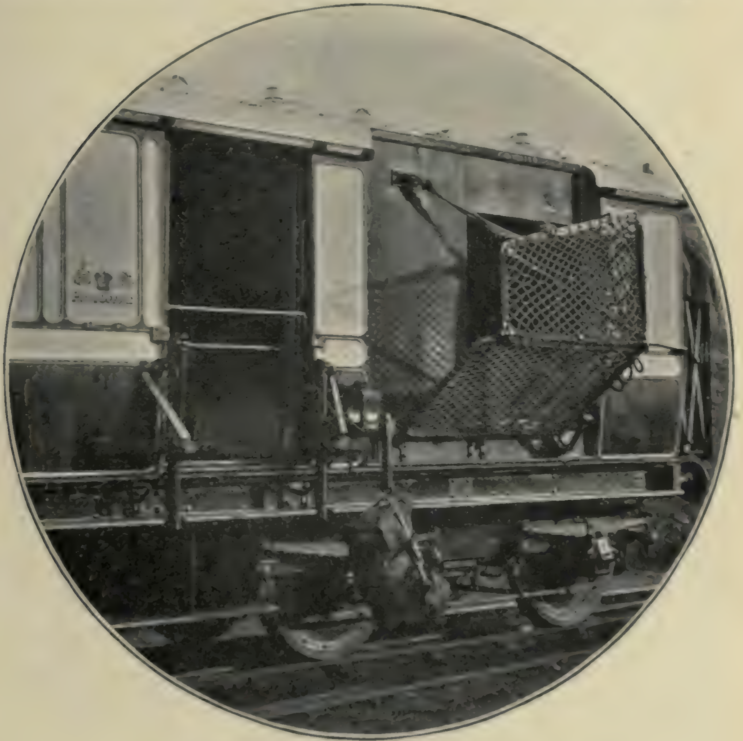
While the puzzle was being thought over, it happened that the *Prince of Wales*, an iron steamer, built at Blackwall, instead of entering the water at her launch was hung up on her bilge between the water and the wharf, and lay there, 110 ft. long, uninjured in her construction. This gave the engineer the idea that he could run the line through a hollow girder if the girder were strong enough to support itself. William Fairbairn, who, when an apprentice, had minded the engine at Willington while George Stephenson was earning a little extra by heaving ballast out of ships' holds, and had assisted in the building of Birkinshaw's Bedlington ironworks near Morpeth, was consulted. He made a series of experimental models to discover the best form of the tubular beam, beginning with cylinders and ending with a rectangle having hollow cells in the top to strengthen it.

The 12.5 p.m. Liverpool to Euston Express, at Crewe.

The tubes were built on wooden stages just at high-water mark on the Carnarvonshire side, and floated into their places at the foot of the piers. Their position was determined by a 12-in. rope to be paid out to a fixed mark from the Llanfair capstan—the Llanfair of so many supernumerary syllables—"the coils of the rope unfortunately overrode each other upon this capstan, so that it could not be paid out. In resisting the motion of the tube, the capstan was bodily dragged out of the platform by the action of the pawls, and the tube was in imminent danger of being carried away by the stream as the pontoons crashed against the rocks. The men at the capstan were all knocked down, and some of them thrown into the water, though they made every exertion to arrest the motion of the capstan-bars. In this dilemma Mr. Rolfe, who had charge of the capstan, with great presence of mind called the visitors on shore to his assistance; and handing out the spare coil of the 12-in. line into the field at the back of the capstan, it was carried with great rapidity up the field, and a crowd of people, men, women, and children, holding on to this huge cable, arrested the progress of the tube, which was at length brought safely against the buttress and veered round." The tubes were placed with their ends in grooves in the masonry, and lifted inch by inch by hydraulic power, the grooves being filled in with masonry as they rose, so that at every stop they had something to rest on. The Bramah press cylinders held 81½ gallons each, the pressure was equal to a head of nearly 5½ miles, the greatest weight lifted was 1144 tons, and once the weight was so great that the bottom of one of the presses was burst out with it.

Really it is a handsomer bridge than Telford's crossing the strait close by. The same cannot be said of Stephenson's tubular bridge at Conway, which runs alongside a Telford suspension bridge built in the same manner, so as to look like a long drawbridge from the castle instead of carrying the Holyhead coach road, as does the other suspension bridge across the Menai Straits.

It was to join up with the Chester & Holyhead and the Manchester & Birmingham that the amalgamation took place in 1846, the Grand Junction controlling the links between Birmingham and Chester, and Stafford and Crewe, where they had placed their locomotive works in 1842, the founder being Francis Trevithick, the son of the locomotive's inventor. He was absorbed with the works by the North Western, and was locomotive superintendent of the northern division until 1857, the southern division having its headquarters at Wolverton, which has been devoted to carriages only since the concentration of the engine work at Crewe in 1862 under Trevithick's successor, John Ramsbottom, who had been locomotive superintendent of the Manchester & Birmingham.



The Travelling Post Office.
Gear in position for picking up and dropping Mails.

To Ramsbottom we owe the invention of the water-troughs placed between the lines to enable an engine to pick up its water supply as it travels. They were first put down on the North Western in 1860—iron troughs, nowadays about 500 yards long, 17 in. wide, and 6 in. deep, with the water in them kept at a height of 4 in. by automatic valves. Seventy yards from each end the bottom slopes upwards till it is level with the upper edge of the sides, the gradient of the line following the slope, so that the bottom of the trough is all along, whether in or out of water, the same distance below the level of the rail. From the tank of the tender rises a rectangular pipe which curves over and passes out through the bottom for about 18 in., and ends in a movable scoop which can be let down when required. As the trough is passed over at a speed of 22 miles an hour or more the water is picked up to the amount of 400 gallons during the quarter-mile. These troughs, which rendered long distance running easier by keeping the size of the tenders within reasonable limits, are now in use on most of our main lines.

When the railway came to it, Crewe had thirty inhabitants ; it now has more than as many thousands. When the buildings were put up in 1843 the site of the works occupied two acres and a half ; they now extend over 137 acres, of which 48 acres are covered with buildings. The Grand Junction had 75 engines ; the North Western has 3000 engines, and in a year they run 50,000,000 miles, that is more than two thousand times the distance round the globe. Crewe began with about 100 men ; it now employs over 8000, to which may be added 700 drivers, firemen, and others in the steam sheds ; and in comparing it with the works of other companies it should be borne in mind that the carriage works are at Wolverton and the wagon works at Earlestown, giving employment to 5500 more. The reason of its magnitude is that it produces every part of a locomotive except the brass tubes, copper plates, and firebricks, from the raw material. It even makes bricks and tiles and drain-pipes in a Hoffman's circular kiln, and in its mortar-mills it makes the mortar with which, and the bricks, the North Western builds its engine-sheds and such-like. In fact it seems to attend to all the machinery except the 8000 clocks and watches that the company endeavours to keep accurate.

Strolling among the miscellanies you find men making iron fencing, artificial limbs, buckets, pumps and cranes, lamps, harness-chains and ship cables ; and among other unexpected things is a steam laundry, to which come the dirty engine-cloths from all parts of the system, the grease from them being made into soap at the still more unexpected soap-works a few yards off. In the timber department there is some of the most ingenious machinery in existence, all driven from below, with endless travellers under the floors clearing off continuously the sawdust, chips, and shavings to be used up in the furnaces, so that there is no inflammable rubbish and no waste.

In and out along the mile and a half of workshops runs an 18-in. railway, 5 miles long, which began with the pigmy engines built to tow barges on the Shropshire Canal; and of course there is plenty of the ordinary track, the rails of which were made at the steel works, for the North Western rolls most of its own rails. Bessemer steel is no longer used, and though the Siemens-Martin process is not so picturesque it is quite as interesting, particularly when the lumps of ore are scattered in to skip about on the shimmering sea ; and the steel-making plant consists of ten of these melting furnaces, capable of a total output of 70,000 tons a year.

It is when the cast steel ingot, 40 in. long and 14 in. square, emerges from the reverberatory furnace, glowing in all the fire colours, that matters become definite, though it seems an unlikely lump to make a railway rail of. Into the cogging-mill it is run, a massive mangle with rollers more than a yard in diameter, and five huge grooves in them of different sizes. Through the largest it passes, then through the smaller in succession, until it leaves the fifth as a lump of about 8 ft. long with a section 10 in. by 8 in. Instantly it is whipped off to the rolling-mill, and through it thirteen times it goes, ringing and clanging at a higher note each time it falls a longer and thinner bar, the thirteenth delivery leaving it over 60 ft. long. Then a saw shrieks through its ends to trim them, and it is straightened and drilled, and becomes a finished regulation rail 60 ft. long, weighing 95 lb. to the yard.

For the improvement of artillery Henry Bessemer invented a revolving projectile requiring so heavy a charge of powder that no gun could stand the strain. To make the gun that would not wear out in a week he set to work to improve the metal until he invented the converter, and by it revolutionised the steel trade. The steel for the purposes of war came into use for the purposes of peace. For one thing it was excellent, namely railway rails, the making of which the North Western was the first to enter upon. The first steel rail was laid under Chalk Farm bridge on the 9th of May 1862; millions of wheels passed over it, and the adjoining iron rails were replaced seven times before it was taken up without being turned.

The steel rail made it possible to double the weight carried on the wheel, and with its introduction came the increase in the weight of the train and the size of the engine, whose hauling power increases with every increase of weight on its driving wheels. Comparing the present rails with those of the Liverpool & Manchester, and others at South Kensington, the steps in the search for strength and endurance are clearly shown—the fish-bellied rail; the single-headed girder rail; the parallel rail with the small lower flange; the Vignoles rail with a flat foot; the bridge rails of Brunel; the double-headed rail of Locke, intended to be turned when one side was worn out, and abandoned owing to the indentations received in the chairs; and finally the bull-headed rail in which the top alone is used for running on, the lower flange being the means of attachment.

A railroad is not so simple as it looks. In the case of the North Western the formation level for the double track is 30 ft. across ; it is gently arched in the middle and sloped off at its edges for drainage purposes ; on it is placed a layer of stone pitching extending to within a couple of feet of the slopes, and over that comes the stone ballast, mostly of slag; in this are embedded the sleepers of creosoted Baltic pine, 5 in. thick, each sleeper weighing 153 lb., and there are 24 of them to each pair of 60-ft. rails; on the sleepers rest the chairs with a pad of hair-felt between the metal and the wood, the jaw of each chair having four grooves in its inner surface to allow the compressed oak key to expand and keep tight. Joining the rails are the fishplates 18 in. long, bolted in position by four bolts, the plates not being flat but slightly curved so that their edges take a bearing against the upper and lower flanges of the rail and there is a space between the inner side of the plate and the flat of the rail. In fact from the formation level to the top of the rail the road

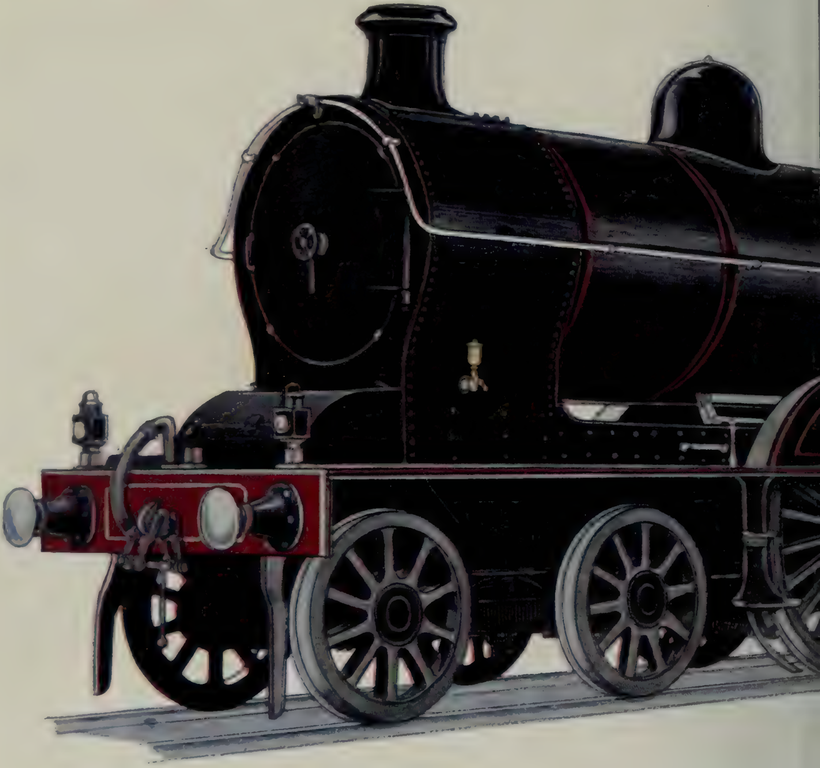
The Boat Express passing out of the Britannia Tubular Bridge.

is 30 in. deep, and in every mile of double track there are 500 tons of steel, to say nothing of the wood and stone.

The road has to be substantial to carry the rolling weight of the monster engines now put upon it. At Crewe you look upon these from the rail level and fully appreciate their dimensions. Here they come for overhaul; goods engines in one place, passenger engines in another, long rows of them, whose names and numbers, if nothing else, so many schoolboys know; and you can almost tell their age by the height of their shoulders.

The locomotive boiler has become so large of late that the roof of the boiler shop has had to be raised, and a mighty thing a boiler looks as it is slung vertically for the hydraulic gap riveter to get at it. The shop is big enough, over 100 ft. across and more than a furlong in length, to build 200 boilers at a time and deal with 3000 in a year; and here, amid the needful machinery, is a crowd of them in all stages, including the stage in which they are tested by steam, then by hydraulic, and then by steam to more than their working pressure. Adjoining this boiler shop is the flanging shop with its hydraulic presses, one of which can give a squeeze of 650 tons; to them, from the gas furnaces near by, come the steel firebox plates glowing hot, with the air in a tremor above them, to be flanged at one operation, slowly, gently, irresistibly, with about as much trouble as so many tea-trays.

Contrasting with the boiler shop is the quiet, picturesque foundry where, amid the haze that fills the ample area, the moulders handle and finger the sand as deftly as a potter does the clay, and the dazzling molten metal runs from the furnaces and pours from the ladles with little spurts of flame. There is one foundry in which rail chairs are cast and nothing else, just as among the timber there is a key department where the oak is cut up into keys by the sawing machine that delivers them automatically into tanks that hold 30,000 at a time, to be steamed and passed on into

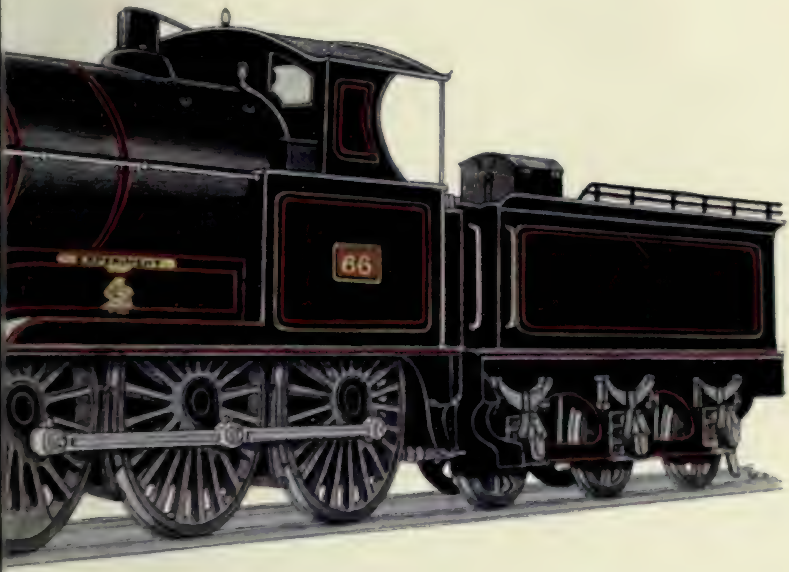


THE LONDON & NOR

EXPRESS PASSENGER LOCOMOT

DESIGNED BY MR. GE

BOILER	Length	12′ 7⅜″	FIRE BOX	Length (outside)	8′ 2″
	Diameter	5′ 0¾″		Width	4′ 1″
CYLINDERS	Diameter	1′ 7″	HEATING SURFACE	Tubes	1857 sq. ft.
	Stroke	2′ 2″		Fire box	133 ,,
TUBES	No.	291			



WESTERN RAILWAY

. No. 66, "EXPERIMENT" CLASS

E WHALE, M.INST.C.E.

DIAMETER OF WHEELS	Bogie	3′ 9″
	Coupled	6′ 3″

GRATE AREA . . . . . 25 sq. ft.

WORKING PRESSURE 175 lb. per sq. inch.

		Tons.	Cwt.
WEIGHT IN WORKING ORDER	Engine . .	65	15
	Tender . .	37	0
	Total . . Tons	102	15

WATER CAPACITY . . . 3000 galls.

COAL CAPACITY . . . . . 6 tons.

moving cylinders that dust them with blacklead and pass them on to be compressed in steel dies and thence loaded through a pipe into the wagon that takes them to the stores.

But these are small things compared with the steel foundry where the three melting furnaces produce forty tons of castings—wheels, motion-plates, horn-blocks, and sundries—a week; or the steel forge with its presses and hammers, its punching and shearing machines, its 7-ft. saws that screech through a 9-in. axle in some five-and-twenty seconds as their jagged edges whirl at 13,000 ft. a minute, its plate and axle mill, its spring mill and tyre mill. Tyre-making looks quite easy; the pressing of the conical ingot into a thick disk, the pressing of the hole in the disk and the pushing out of the centre-piece, the pair of rings reheated

Transporter Bridge across the Manchester Ship Canal.

and pressed into one which in two operations in the vertical rolls becomes a finished tyre.

Busiest of all is the fitting shop, where everything is finished to templates and standard gauges so as to be interchangeable—and there are more than 2000 parts in a standard engine; and most interesting, because most comprehensible, are the erecting shops where the engines are put together, and you see them rising from their foundations to their chimneys like a row of new cottages.

An engine begins with the placing of the two frames on the balks; here is one in which the temporary crossbars have been added to keep the frames parallel while the cylinders are slung into position, and we see them being bolted in. The motion-plate, otherwise the spectacle-plate, will come next to act as the first permanent stay between the frames and serve other purposes as well. Then come the stay-plate and the foot-plate to complete the main framework. Into the square-headed notches, on the under surfaces of the frames, the guides for the axle-boxes—the horn-blocks—will be bolted and the foundation will be ready for checking by almost every variety of measurement, lengthways, crossways, diagonally, for distance and direction, the main object being to ensure that the centre lines of the cylinders are parallel to the frames, and not the fraction of a second out of a right angle with the horn-blocks.

Here is another, duly examined and found correct, which is being finally fixed together. On it will come the angle-plates for the side-plates to be riveted to, all the rivet holes being driven by an electric drilling machine, and the slings or supports for the springs will be put on. Under another engine men are fitting into the horn-blocks the axle-boxes, which will have to have their bearing surfaces bedded on the wheel journals before they are done with.

Next comes drifting through the shed the boiler which no one sees in public, for it will have to be lagged with felt and coated with the lagging-plates of steel and their numerous layers of paint. As it hangs in mid-air it threatens to crush any foundation it may rest upon, but down it is eased, fairly and squarely, the firebox slipping in just in front of the foot-plate, and the smokebox-plate entering between the cylinders. At the rear end it rests on the expansion-brackets riveted to the frames, and on them it will slide as it lengthens with heat, for it will be half an inch longer in steam than when it is cold, and hence the only place in which a boiler is rigidly fixed is at the smokebox tube-plate.

An Invalid Car—Passengers can be taken to any station in the country without disturbance.

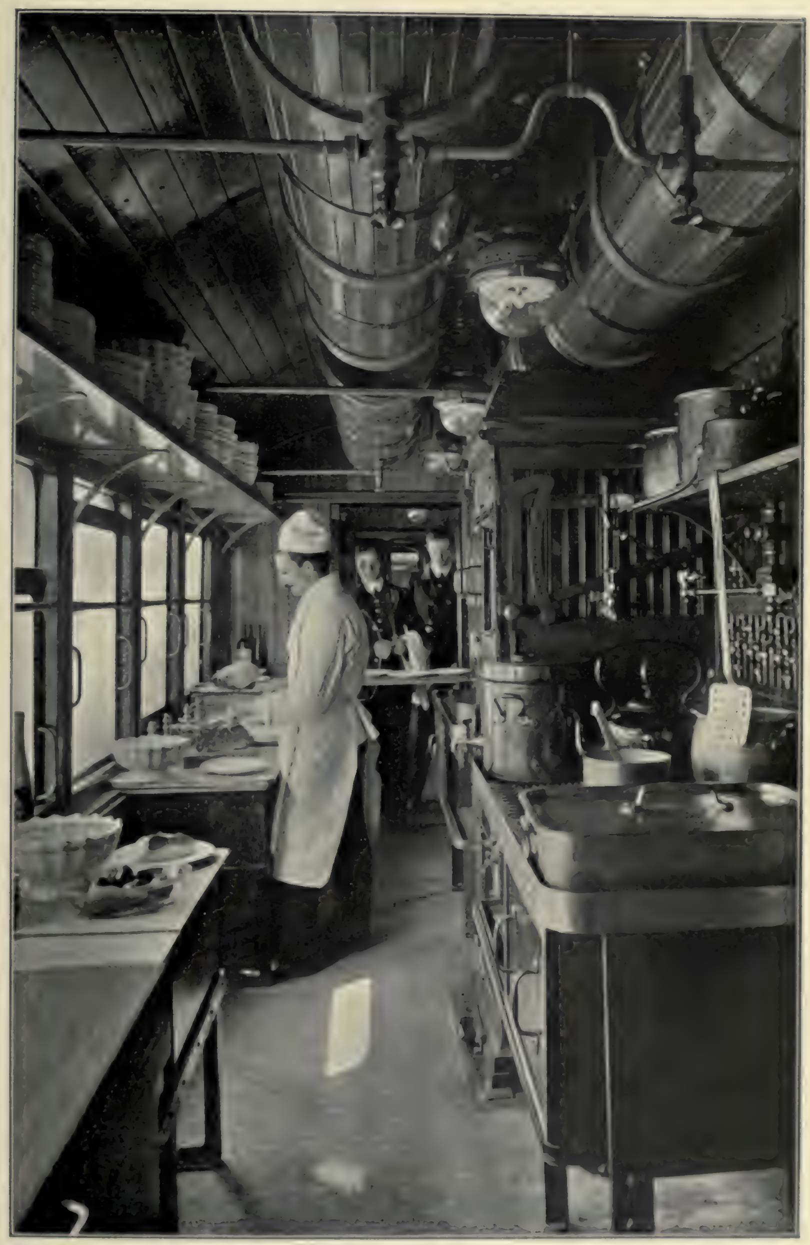
In another engine the boiler is in place and the smokebox is being fastened to the frames. In it is the blast-pipe, which has to be as exact in position as the cylinders and horn-blocks, for through it passes the exhaust steam to cause the vacuum that makes the draught on which the fire depends, and if it is not central with the chimney there will be trouble; as there will be if the door of the smokebox that seems to fit no closer than the lid of a kettle is not airtight.

Meanwhile the machinery is being put together below. The pistons and their rods are being set in the cylinders with their rings and packing. The crossheads have to go on, and the slide-bars and valve gear, and—well, and the rest, for we are going into too much detail for our space—and the cab has to be built on the foot-plate, and the chimney, not much higher than a man's hat nowadays, has to be placed on the smokebox.

Then the chains are passed under the engine for a heavy lift; they are hitched on to the cranes, and up in the air it moves for the wheels to be run under it. Judging the distance, the men at each wheel stand ready to catch it without a jar as it comes down and fits as it was built to do. The linking and joining and putting in of a myriad things will follow, until completion comes with the buffer-plank and couplings. And then a couple of cranes pick it up as if it were a baby and put it on the central track, where it has its first little run—to the weighing machine.

When the London & Birmingham began it jobbed its engines from Bury's, but that did not last long, and since then it has built at Crewe some 5000 engines of its own. The first thousand was completed in 1866 under Mr. Ramsbottom, the second in 1876, the third in 1887, and the fourth in 1900 were all constructed under Mr. F. W. Webb, who retired in 1903, to be succeeded by his assistant Mr. George Whale, who has recently been succeeded by Mr. C. J. Bowen Cooke. One thing is remarkable, and that is that not until the Black Prince in 1897 did the North Western build an engine with a bogie, the bogie differing from all others in not having a centre-pin.

Mr. Trevithick built a large number of excellent outside cylinder engines, among them being the famous Cornwall,



II.—C 28

IN THE KITCHEN CAR OF THE AMERICAN SPECIAL

which had 8 ft. 6 in. driving wheels and is said to have travelled down Madeley bank at 117 miles an hour. As built in 1847 this engine was a 4-2-2 with the boiler below the driving axle, the idea being to give her the lowest possible centre of gravity ; her cylinders were 17½ in. by 24 in. ; her heating surface was 1046 sq. ft. ; the excentric was on the outside of the driving wheels and larger in diameter than the throw of the crank ; and the regulator was on the top of the boiler. As thus built she was somewhat of a failure, and she was rebuilt by Mr. Ramsbottom as a 2-2-2 in 1858, with her boiler above the driving axle in the usual way. She was known for long as one of the fastest of engines ; and for thirteen years she worked the expresses between Liverpool and Manchester, running altogether about a million miles before becoming obsolete.

In 1862 Mr. Ramsbottom put on the road the Lady of the Lake, one of the Problem class of high-speed engines. She was a 2-2-2 with 7 ft. 7½ in. driving wheels, 3 ft. 7½ in. leaders and trailers, cylinders 16 in. by 24 in., heating surface 1000 sq. ft., and she weighed 27 tons. In 1876 the Lady of the Lake was rebuilt by Mr. Webb, and made another start with 7 ft. 9 in. driving wheels, 3 ft. 9 in. drivers and trailers, cylinders as before, heating surface 1047 sq. ft., her weight being 29 tons 6 cwt.

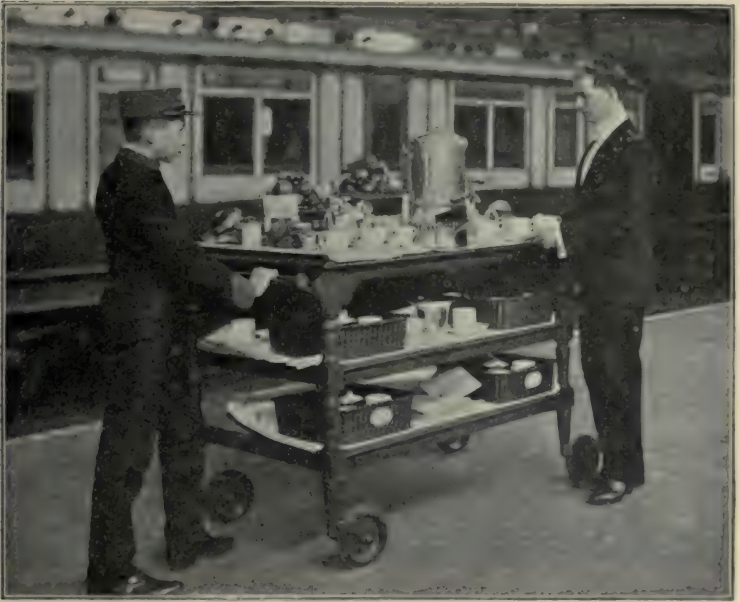
Another famous class introduced by Mr. Ramsbottom was that to which the Newton belonged, built in 1866. These were 2-4-0's with 6 ft. 9 in. coupled wheels and 3 ft. 9 in. leaders, cylinders 17 in. by 24 in., heating surface 1068 sq. ft., and a weight of 29 tons 14 cwt. In 1874 Mr. Webb built the Charles Dickens, household words among railwaymen ; she had 6 ft. 9 in. coupled wheels and 3 ft. 9 in. leaders, being also a 2-4-0, and she also had 17 in. by 24 in. cylinders, but her heating surface was 1063 sq. ft., and her weight 32 tons 15 cwt. ; another difference being that while Mr. Ramsbottom worked at 120-lb. pressure, Mr. Webb used 150 lb.

This engine continued to run her daily trip between Manchester and London until the 2,000,000 miles were completed, and then she retired with a world's record. Another of this Precedent class was the Hardwicke, which in 1895 made the record run from Crewe to Carlisle, 141 miles, at the average speed of 67·2 miles an hour.

Having made excellent simples, Mr. Webb turned his attention to compounds, of which in sixteen years he built a hundred of the 3-cylinder type. First came the Experiments, of which 30 were built, then the 40 Dreadnoughts, then the Teutonics, the 8-wheeled Greater Britains and the 8-wheelers of the John Hick class, of which there were 10 each. The Experiment was not quite an experiment, for the experimental engine was one of Trevithick's old singles with 15-in. cylinders, one of which Mr. Webb reduced to 9 in. by lining it. This engine he set to work on the Ashby and Nuneaton branch in 1878, and the experience thereby gained led him to build his first Compound with the two equal high-pressure outside cylinders working the rear drivers and the low-pressure cylinder between the frames working the front drivers. In her the high-pressure cylinders were 11½ in. by 24 in. and the low-pressure cylinder 26 in. by 24 in., but in the Compound and those that followed the high-pressures were 13 in. ; in all the driving wheels were 6 ft. 9 in. and the heating surface 1083.

In the Dreadnoughts, which began in 1884, the driving wheels were 6 ft. 3 in., the cylinders were 14 in. by 24 in. and 30 in. by 24 in., the heating surface was 1400, and they were 4¾ tons heavier, the weight being 42½ tons. The Teutonics, which first appeared in March 1889, had driving wheels 10 in. larger and leading wheels 4½ in. larger, 4 ft. 1½ in. instead of 3 ft. 9 in., the weight being 3 tons more. The Jeanie Deans belonged to this class—the only one whose name did not end in ic—as also did the Ionic, which in 1905 ran the 299 miles from Euston to Carlisle without a stop.

The Greater Britain, turned out in 1891, had similar wheels, with a pair of trailers of the same size as the leaders, and the high-pressure cylinders were 15 in. instead of 14 in., and the heating surface was 1541 instead of 1400, the weight being increased to 52 tons 2 cwt. In the middle of the boiler was a combustion-chamber into which led copper tubes from the firebox and out of which led 156 brass tubes into the smokebox. It was one of this class, the Queen Empress, that went to the Chicago Exhibition in 1893, and travelled 1500 miles on American railroads under her own steam. The other 8-wheelers had 6-ft. driving wheels. Like all the 3-cylinder compounds they went to Crewe to return no more, all of them condemned to be broken up.



A Tea Wagon at Euston.

In 1897 Mr. Webb produced the Black Prince, a 4-cylinder compound with two high-pressure cylinders of 15 in. and two low-pressure cylinders of 19½ in. This was an 8-wheeler, but instead of trailing wheels there was a leading bogie, the drivers being 7 ft. 1 in. and the bogie wheels 3 ft. 9 in. There were two blast-pipes and two chimneys in one flat casing, the smokebox being divided so that half the tubes discharged into one part and half into the other. With low-pressure cylinders of 20½ in. there were 39 similar engines forming the Diamond Jubilee class; and 40 more 4-cylinder compounds followed of the Alfred the Great type, which were practically the same with larger boilers. These were the last compounds built at Crewe, Mr. Whale being in favour of the simple life, but he took the Alfreds in hand and greatly improved them by giving them a separate motion for the high-pressure engine, which as originally constructed worked off the motion of the low-pressure one.

Mr. Webb's Precursor of 1874 was a 2–4–0, Mr. Whale's Precursor of 1904 was a 4–4–0; and she was the first North Western engine with a steel-framed tender, for up till then all the Crewe tenders, even those of the express compounds, were timber-framed and as designed by Trevithick. She was the first of a large class having cylinders 19 in. by 26 in., heating surface 2009, driving wheels 6 ft. 9 in., bogie wheels 3 ft. 9 in., and a weight of 59¾ tons. These powerful engines did away with the double-heading that had become characteristic of the company's heavy trains, but even they were unequal to mounting alone that long six-mile climb at 1 in 75 from Tebay to Shap summit. To be good enough for that, Mr. Whale introduced in 1905 the second Experiment, a 4–6–0, with 19 in. by 26 in. cylinders, coupled wheels 6 ft. 3 in., bogies 3 ft. 9 in., heating surface 2041, working pressure, as that of the Precursors, 175, weight of engine 65¾ tons, weight of tender 37 tons. These two classes are now doing the main express work of the line, taking along the 350-ton trains as easily as the heavy 74¾-ton 10-wheel tanks are handling the shorter distance traffic;

and, including all station stops and incidental slows, they are averaging over 55 miles an hour.

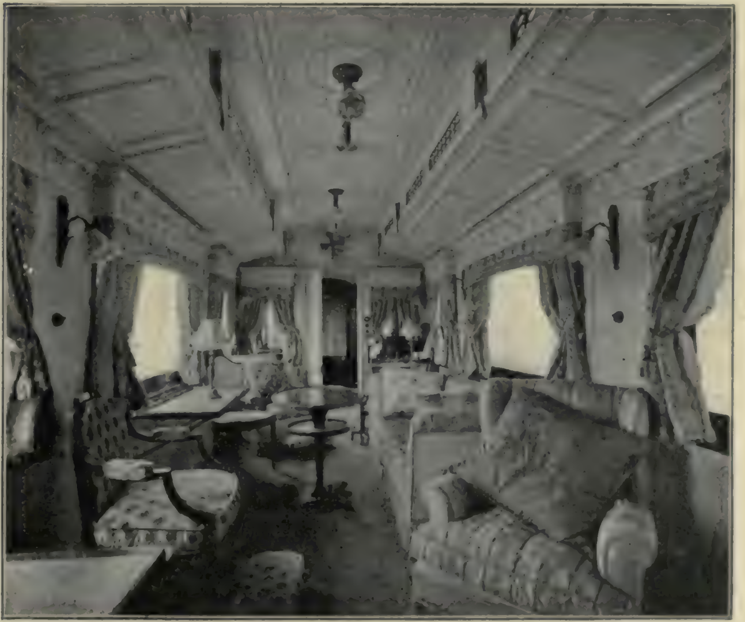
As the engines have improved so have the carriages even of the highest class. The North Western built a carriage for Queen Adelaide as far back as 1842 which is still preserved at Wolverton, as is also the saloon carriage which was made for Queen Victoria in 1905 by joining together the two separate saloons built in 1869 and mounting them on one under-frame. In 1902 the present royal train was built at the company's expense as the others were, and as all are in this country, the train being the company's property and kept for the use of the royal party—who pay their fares like other passengers, including the extra mileage charge for the special. This is a train so designed that the passengers are expected to forget that they are in a train, so smooth and silent is its movement, so tastefully is it furnished and decorated. With their silver-mounted bedsteads and easy-chairs and window draperies there is nothing except the roof to show that the apartments are sections of a railway carriage.

Conway Castle and Suspension Bridge. The railway bridge is on the left and the trains run through the square tower.

When the royal train is on its journey the most elaborate precautions are taken to ensure its safety. No ordinary signalling will do, and yet what a lot of it there is! Along the 158 miles between London and Crewe there are 160 signalmen in 132 signal-boxes, and for each non-stop train these men have to lower 300 signals to "line clear" and pull over 360 levers; the train travels over 180 pairs of points, and passes 80 signals at danger at branches and junctions to keep the main line safe; and some 1450 messages about it are exchanged by telephone and the block instruments between the signalmen.

In 1864, Queen Victoria wrote her letter to the railway companies expressing the hope that the same security should be ensured for all her people as was so carefully provided for herself—a well-intentioned hope impossible to be realised, for it meant, and would mean, that no train could follow another train on any line at a less interval than half an hour, and that the railway should be practically closed all day long except at the terminal stations. When the Queen travelled, a pilot engine was run a quarter of an hour in front of her throughout the journey, and no train or vehicle except this pilot was allowed to proceed upon or cross the line during at least half an hour before the time at which the royal train was booked to pass. All shunting work was stopped on the adjoining lines during the same period, and no engine or train could leave a station or siding upon the same line for fifteen minutes after she had gone by.

In addition to this no light engine or train, except a mail or postal train, could run between any two signal-boxes between the passing of the pilot and the passing of the Queen. All the facing points were bolted to prevent the royal train getting on the wrong line; all the level-crossing gates where there were no gate-keepers were locked an hour before the train was due; every station and crossing was guarded to keep trespassers off the line; all along the line platelayers with flags by day and lamps by night were on the watch to keep the road clear; the train was accompanied by a staff of workmen who watched each side of it so as to notice any irregularity in the running of the carriages; and it was telegraphed from point to point, and carried an instrument by which it could telegraph at any time on the journey. And similar precautions are taken with the royal train now. Everything has to give place to it except the breakdown train, but then the breakdown is on its message of life or death and travels at speeds that are not recorded lest the timid should avoid the route.



Inside the Queen's Carriage—the Day Saloon.

One royal journey, however, is on the list very different to all this, and may have led to it. It occurred when Frank Trevithick was locomotive superintendent at Crewe. The story is too strange to be told except at first hand,

and in his own words, therefore, this is how he drove the Queen.

"About the year 1846, on a rainy, blowing, autumnal Saturday night, the writer was summoned, from nursing an influenza cold, to the railway station. Her Majesty, Prince Albert, and the rest of the Royal Family, had unexpectedly arrived and desired to be in London by ten the following morning. Continued rain had caused the line to be unsafe in places, except at comparatively slow speeds. Saturday night is proverbially a bad time for finding people wanted in a hurry. However, at six the next morning, in dim light and blinding rain, the Royal train was in readiness, and Her Majesty punctual to the minute, when, after a little animated delay for the lady-in-waiting, a start was made, and the required speed of forty miles an hour steadily run, until a providential disobedience of orders by the pilot-engine man caused the steam to be instantly shut off, the brakes applied, and the speed reduced to one half; fog-signals exploded in close proximity to the danger; red flags were hurriedly unfurled, and in a moment the engine rolled as a ship in a storm through an alarmed group of a hundred navvies, who, thinking it a quiet day, had raised the rails and sleepers a foot above their bed of soft clay that a thick layer of ballast might be shovelled under them. For a quarter of a mile did the precious freight pass safely over this bridge of rails supported on brickbats, the only injury being a bent driving axle and broken bearing-brasses, with which the engine kept time to the next relieving station and then broke down."

Next in luxury to the royal train comes the family coach or semi-royal saloon, of recent introduction. Sleeping carriages were introduced by Ashburys of Manchester in 1873, and were first used on the Great Northern and North Eastern. In each compartment were three beds, obtained by pulling down the back of the seat. The beds were un-

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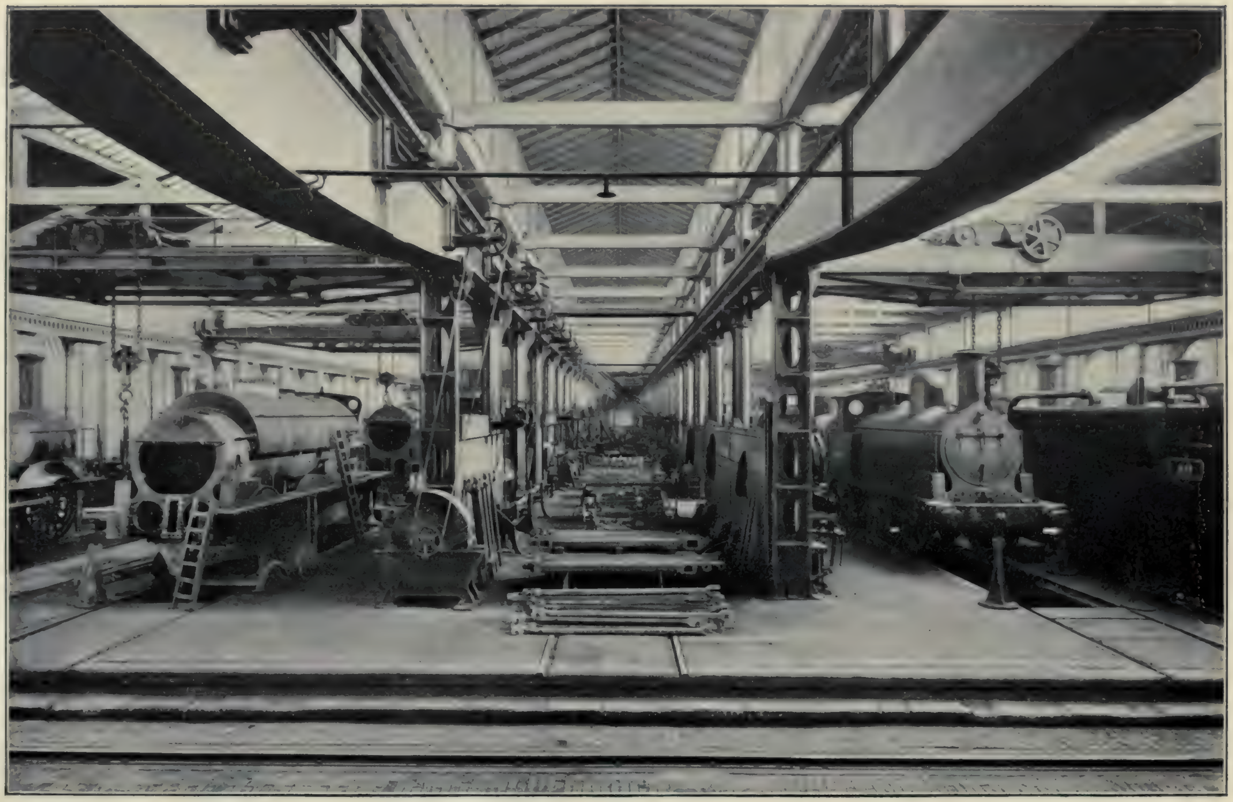


CREWE WORKS—NO. 5 ERECTING SHOP

pleasantly suggestive of coffins, and, particularly the middle one, were not easy to get into. Then Colonel Mann designed a sleeper that was adopted on some of the continental lines, but did not meet with the approval of the North Western, whose directors ordered Mr. Bore of Wolverton to see what he could do ; and the result was the first North Western sleeping carriage in which the four day seats in each compartment could be made into two beds, while hammocks coming down from the roof gave two more. These came into daily use in February 1874 on the Glasgow "limited mail," that is a train confined to so many carriages that took so many passengers, and if you were not there in time to get a seat you were left on the platform if the booking clerk had accidentally issued too many tickets. The trouble caused by the last to come who wanted three seats and could only get two may be imagined, and it led to the abolition of both the Scottish and Irish limited mails.

In March 1875 sleeping saloons began to run between Euston and Holyhead. "The provision of this night facility," says G. P. Neele, "made, I fancy, a considerable inroad into the little perquisites that had been recognised, the illegitimate earnings of the mail guards for the provision of the two sticks which it had been their custom to furnish to their likely patrons : by means of these sticks and a spare cushion the space in the compartment was comfortably bridged over and a long, sofa-shaped seat established ; indeed, these two sticks were quite a portion of the officer's travelling stock." Similar night saloons were put on between Euston and Liverpool on the 1st of April ; and in July, to attract American travellers, day saloons were run by the midday train ; but it was not until 1882 that twin saloons appeared on the line.

When railways came into existence the porters were allowed to keep bookstalls as a sort of perquisite, and very curious literature some of them provided. It was on the North Western that the reform began. In 1851, W. H.

Smith & Son secured their first contract for the line, and by his care in the selection of literature, to which no exception could be taken, young W. H. Smith, afterwards First Lord of the Admiralty, obtained the nickname of "the North Western Missionary." Within eleven years Smith's bookstalls were on every line of importance in England, and he it was who started the placarding of the station walls with advertisements, for which some of us are not so grateful. Like most things, this bookstall idea was but the development of the existing, for the elder Smith had outrun the post, by which all newspapers used to be sent, by despatching them by the fast morning coaches instead of the night mail. To catch the coaches with the papers that came out late he started the red carts with horses good enough to pursue the coaches and overtake them if necessary; and sometimes, with quick changes, when the news was important, the carts went all the way. From the coaches the step was easy to the railways, and from sending them down the road the next step was to take the place of the porters' stalls and sell them at stations on the way. Next to forwarding them by fast train came the sending them by special trains, and this led on to the newspaper trains. From selling books the step was easy to lending them, and thus came about the railway circulating library.

It was Smith's express that took the news of the death of George the Fourth to Dublin before the Government messenger. In those days the Dublin boats ran from Liverpool, where the North Western is now so much in evidence with its American specials to Riverside Station and other facilities for the transatlantic trade. The service from Holyhead has been competitive from the first, for the Government authorised the City of Dublin Steamship Company to supply the mail steamers from there, while at the same time the Chester & Holyhead Railway Company had obtained parliamentary permission to work steamboats; and both lines ran to Kingstown. For years, while the Irish mail was the fastest train out of Euston, the engines had to be changed at Holyhead owing to the Admiralty Pier being too weak to carry the express engine's weight. It was for the convenience of passengers by the Irish trains that in March 1876 luncheon baskets were invented, the first station at which they could be obtained being Chester; and it was for the same trains that in 1880 Mr. Webb introduced his acetate of soda footwarmers that led to so many railway friendships owing to the conversation provoked by the porters tumbling them about and shaking them up when they cooled down—the ice of convention broken by a footwarmer being yet another instance of the influence of the trivial.

Loading a North Western Steamer at Holyhead.

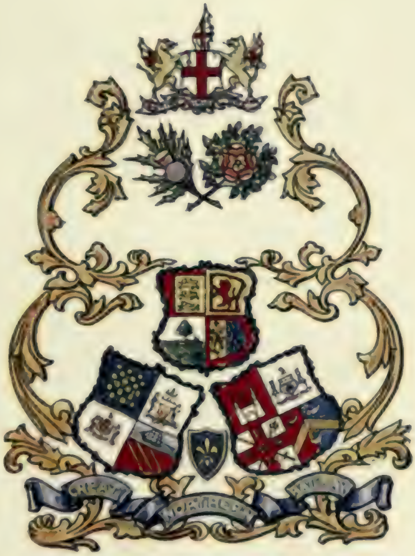
It was not until 1873, the year the North Western boats first went to Greenore, that the Irish service became fixed instead of tidal, and since then matters have so much developed that we have the American liners putting their passengers ashore at Holyhead instead of Liverpool; and Holyhead is only two miles farther from Euston than Fishguard is from Paddington.

Nowadays the North Western has a fleet of seventeen steamers, the newest being the *Rathmore*, on the service to Greenore, and the four sisters going to Dublin, named after the old boats of the Chester & Holyhead, *Scotia*, *Anglia*, *Cambria*, and *Hibernia*, that travel at 22 knots and are among the best afloat.

For whatever is done by the North Western is well done, not excepting the hotels, of which there are eight—those at Euston, Bletchley, Crewe, Birmingham, Liverpool, Holyhead, Dublin, and Greenore.

The *Anglia* leaving Holyhead for Dublin.

THE GREAT NORTHERN



COAT-OF-ARMS

No. 1 Departure Platform at King's Cross.

THE GREAT NORTHERN

THE Great Northern is the first link in the East Coast route to Scotland; and, by means of its own lines, joint lines, running powers and agreements, its working area extends not only over the Border but westward to Liverpool and eastward to Cromer—a development not anticipated when it came into existence as a railroad from London to York.

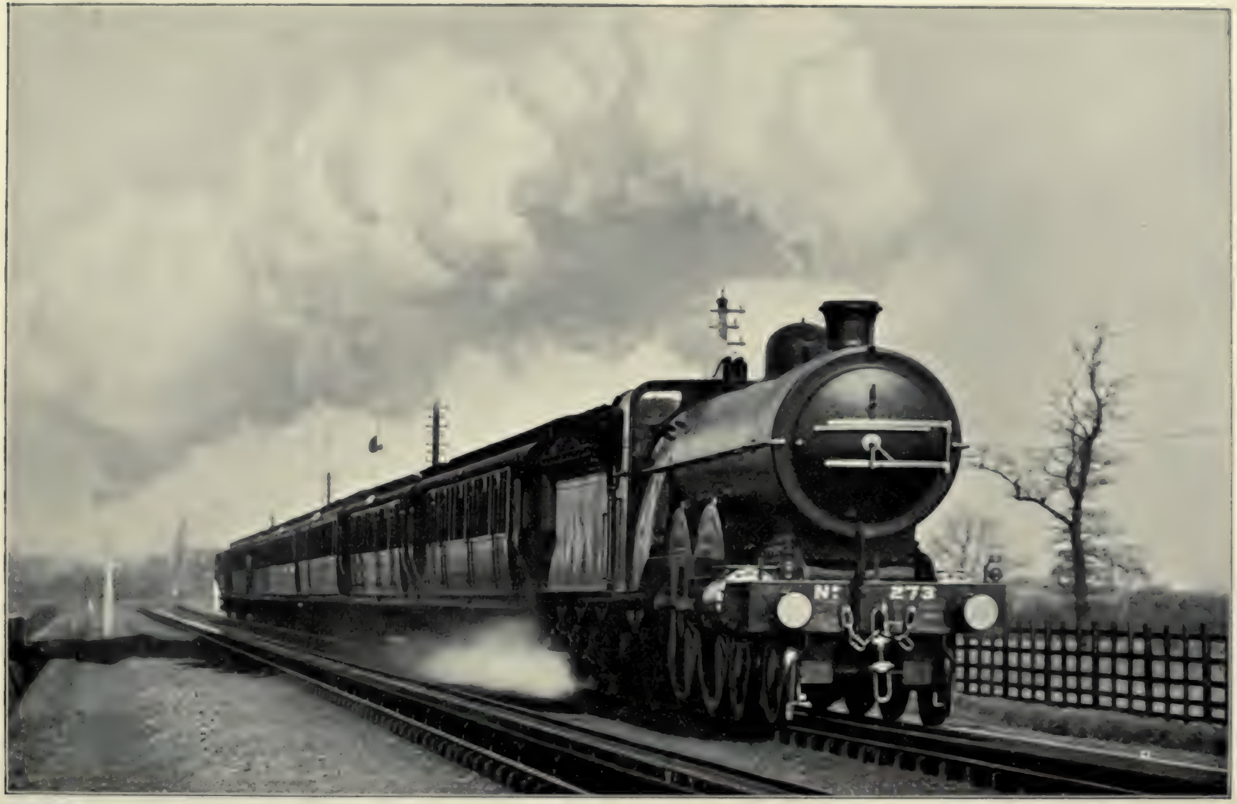
The first railway to Yorkshire was projected by those great company promoters, the Rennies, in 1827. Two years before, they had proposed a line up the valley of the Lea to be continued on to Cambridge; their York line was merely the prolongation of this through Lincoln, and their scheme failed to please and came to nothing.

The real beginning was made in 1835, when Joseph Gibbs, better known perhaps in Brighton matters, apparently on his own account surveyed a route of what he called The Great Northern Railway, the Bill for which was thrown out by the Commons in the following year. Undismayed, Gibbs kept the project alive, and being a busy man he could afford to wait. Eight years went by of scheming and inquiring on the part of other projectors, and in April 1844 there came out the prospectus of another company, the Direct Northern, which was followed a month afterwards by that of the London & York.

Between these companies there were desperate contests, parliamentary, financial, and more or less disgraceful, but it seems a wearisome business to us now, and all that need be said is that after leading one another a terrible time they amalgamated. The London & York absorbed the Great Northern on the 17th of May 1844, and the Direct Northern on the 5th of May 1846, and Gibbs's title, which had been dropped at the first amalgamation, was revived at the second, the united companies becoming the Great Northern Railway, which obtained its Act on the 26th of June 1846.

Not only did the company get its name from Gibbs, but it got its main road. He should have been the engineer, but apparently for Stock Exchange reasons—there was quite enough of Stock Exchange strategy about the Great Northern's early manœuvres—the appointment was given to Joseph Locke, who was called upon to decide between two routes, Gibbs's " through the Towns," and James Walker's " through the Fens," and his verdict was in favour of the former.

Locke did little more. He only held office for a few months, his resignation being dated 17th of September 1844. He was then away in Paris on French railway business, and the letter did not arrive until three days afterwards ; it was a severe blow for the young company, and required to be acted on instantly. Edmund Denison was quite equal to any such emergency. Very late that Friday night he drove over to William Cubitt's house on Clapham Common. It was all in darkness, and Denison knocked for some time without arousing anybody. Then



AN EAST COAST EXPRESS PICKING UP WATER AT FULL SPEED

at a first-floor window appeared Cubitt, with a nightcap on, asking in an angry voice what all the noise was about. "Will you be the engineer of the London & York ?" shouted Denison. "Eh, what ?" said Cubitt. "What has happened to Locke ?" "Resigned. Will you take his place ?" "Yes," said Cubitt; "I will come and see you in the morning." And off went Denison from that midnight interview. Everything was arranged on the Saturday, and the morning newspapers of Monday, 23rd of September 1844, contained an advertisement announcing Locke's resignation and Cubitt's appointment.

The Act authorised the making of 327 miles of railway, of which 186 were to form the main line to York, and Cubitt, assisted by his son Joseph, soon became busy. In November 1846 Thomas Brassey was asked to contract for the section between London and Peterborough, while in January Morton Peto was given the contract from Peterborough to Gainsborough. Brassey had the more difficult job. For three miles he had to cross the fens near Whittlesea Mere, where there was "a quaking bog you could stand upon and shake an acre of it together." Meeting Stephen Ballard by chance at Cambridge, he made him his agent for the works in the fen country, and by his ingenuity the line was laid across the treacherous ground. A hundred acres of faggot-wood were cut down, end to end the stakes were placed to form a platform upon which a layer of peat sods formed a foundation for another bed of stakes; and this was not done hurriedly but gradually, so that the water had time to run out. The effect was to displace the water and leave the solid parts behind; and in alternate layers the building went slowly on until a firm foundation was obtained.

The bridges also were made in a special way. "They were intended to be piled," says Ballard. "The peat was 22 ft. deep, and I pointed out to the engineer the difficulty of sufficiently bracing the piles, their tops being only about

3 ft. above the soft bog. The piling was given up, and we made rafts of timber on which brick walls were built. These gradually sank, care being taken to so dispose the weight as to keep the walls perpendicular, and finally these walls were tested with rails of a greater weight than that of any train that could pass over them. We did not load too quickly, but left it ; we put a little load on, and left it ; and then the water had a chance of escaping. We only compressed the peat beneath the raft, without displacing it, for if we had once displaced it we must have gone down to the solid."

Brassey was much hindered by the failure of the Great Northern people to make the agreed payments on account, and he took the company's bonds in lieu of cash, as also did Ballard, who was paid by a share of the profits. Ballard had to sell his bonds at a loss, but the company afterwards honourably made good all the loss he had sustained. Thus the building of the line went on, Brassey making no claim for the delays occasioned by these financial difficulties,—a very different state of affairs this to what usually happened in railway-making when delay was the contractor's fault and not that of his employers.

On the 1st of March 1848 the first section of the Great Northern was opened for traffic. Of all places on the system it was the thirty miles between Louth and New Holland ! And of this only fourteen miles belonged to the Great Northern, the rest being owned by the Manchester, Sheffield, & Lincolnshire. The next was the 4¼ miles from Doncaster to Askern, the next that from Louth to Peterborough. The section from Maiden Lane—the first London terminus—to Peterborough was opened in August 1850 ; that from Peterborough to Retford in July 1852 ; and on the 14th of October of that year King's Cross was opened on the site of the old small-pox and fever hospital.

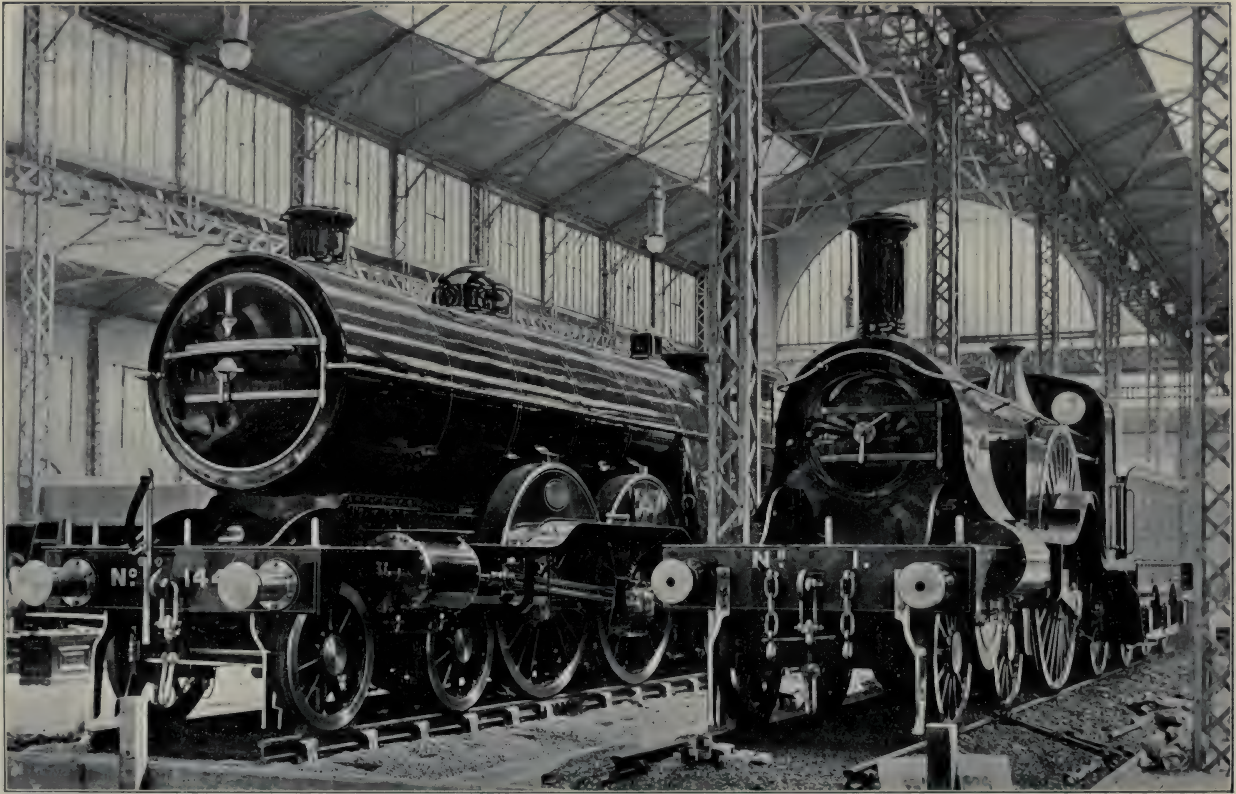
King's Cross was thought much of when it was built. It was then the largest station. We read that " it wore a magnificent appearance" and presented "a vista of extraordinary effect." The effect on some of the shareholders was to make them protest against "the extravagance in erecting so splendid a station," to which Denison replied, unanswerably as usual, "I am authorised to state that it is the cheapest building for what it contains and will contain that can be pointed out in London; I am told—I am not the architect and I do not estimate it—that it will not have cost more than £123,500. If that is the case, I have no difficulty at all in saying that it is a very cheap station. Bear in mind, however, that we paid by arbitration and award, I think, about £65,000 for the two old buildings that stood there, and then we had to excavate the ground before the station was erected; so that I do not pretend to say that the whole cost is only about £123,000."

A powerful Tank Engine used for Local Traffic.

Anyhow, it was the cheapest of the existing London terminals; and for the 13 trains out of it a day, 3 fast and 10 slow, it was large enough. There were two long platforms, arrival and departure, and between them were 14 tracks. The two sheds were, and are, 800 ft. long, 105 ft. wide, and 71 ft. high. The idea of the roof was borrowed by the architect, Sir William Cubitt's nephew, Lewis Cubitt, from the riding-school then recently built for the Czar at Moscow, the ribs being bundles of planks—the planks overlapping each other endways, forming a built-up bow kept stretched by the containing walls, which had to be of unusual strength to resist the thrust. Many people had their doubts about this roof, then the largest in the world, one of the doubters being Mr. Denison's son, in after years Lord Grimthorpe, who, like his father, generally knew what he was about ; and the doubters were right, for the wooden bows of the roof have been replaced by iron girders.

The line was thoroughly good, like all Sir William Cubitt's lines, and, like all of them, it was laid out for fast running. Unlike the South Eastern, its capacities in that respect have been utilised to the full. It was built for speed and it has been used for speed ; but it should be remembered that the Great Northern's business really began north of Grantham where the M. S. & L. came in, and that it was best to get over the intervening distance as soon as possible. That stretch of 105 miles was practically a line of approach along which much was gained by saving time. Farther north up to Doncaster the trade thickened, and Doncaster is really the end of the main line. Peterborough did not become of importance until the company's good habits had become second nature. It was the evident advantage of getting to work quickly that led the Great Northern to adopt speed as a policy from the very early days, and the reason still holds good. Speed may, or may not, pay everywhere, but it certainly has paid and does pay on the King's Cross route.

The line has no gradients or curves of importance. It rises to Holloway at 1 in 110 ; then comes a gentle rise to Hornsey, followed by a long rise of 1 in 200 from Wood Green to Potter's Bar. Then the profile goes down to Hatfield and up to Welwyn along the great Digswell



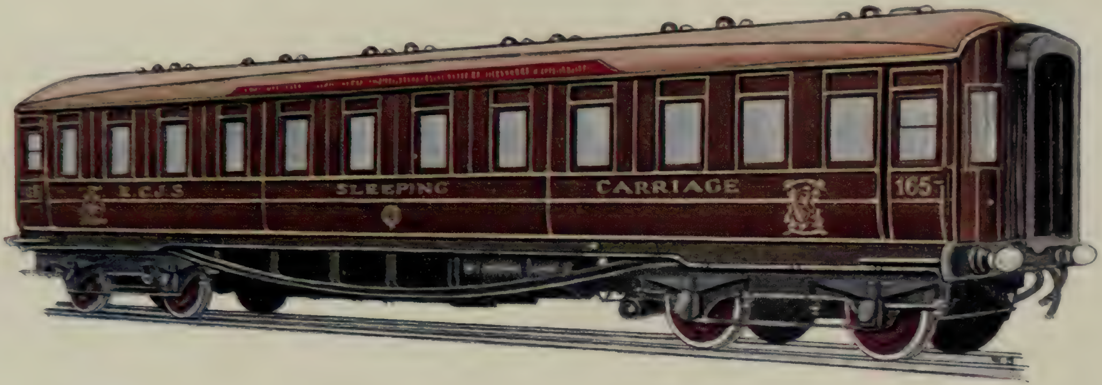
PAST AND PRESENT—THE "FLYING SCOTSMAN" IN 1870 AND 1910 viaduct of forty arches that carries the line 89 ft. above the Mimram, then through the tunnel of the three trains and up and down to Stevenage; the descent to Arlesey follows, and on to Peterborough there is nothing to trouble about. Beyond Peterborough the line rises until at 1 in 178 it attains 347 ft. at Stoke between Corby and Great Ponton, from which at 1 in 180 it descends to Grantham. Altogether there are twenty-five stretches of dead level, but only that at Holme is of any length. Between Grantham and Doncaster the line is of the same character, and there is no need to go into detail. The main line rises no higher than Stoke, but the summit level of the system is 877 ft. on the Keighley branch.

"The Great Northern Railway," said Edmund Denison, the famous chairman of the company, "ends in a ploughed field four miles north of Doncaster." That ploughed field was, however, not at Shaftholme Junction, as generally reported. It was at Askern Junction, 4 miles 26 chains north of Doncaster, that is a dozen cricket pitches farther north than Shaftholme, and a little to the west of it, that the Great Northern joined end-on to the Lancashire & Yorkshire, and by way of Knottingley took its trains to York by running for 14 miles on that company's metals, and 19 miles on those of the York & North Midland, which in 1854 amalgamated with other lines as the North Eastern. It was not until 1870 that the North Eastern opened its direct line to the south from York through Selby to join the Great Northern at Shaftholme and form the present route. By many people York is thought to be the northern end of the Great Northern, but its trains get there on 28 miles of the North Eastern, and its highest north is not at York, but at Ripon, 20 miles farther on, which it reaches by way of Harrogate, and enters on North Eastern metals.

From Peterborough goes off its joint line with the Midland which takes its trains to their farthest east at Lowestoft. At Werrington, just beyond Peterborough, begins the Lincolnshire loop which extends up to Grimsby, and takes in Skegness, Mablethorpe, and Lincoln. From Grantham goes its short road to Lincoln, whence it proceeds along its joint line with the Great Eastern which runs from Somersham to Black Carr; and also from Grantham goes off the western branch leading to Nottingham and Derby, and as far as Egginton Junction, whence the North Stafford takes on the Northern trains to the Northern outlier beyond Uttoxeter. From Retford, Sheffield and Manchester are reached by way of the Great Central; another route to Manchester being over the Cheshire Lines, which from both Manchester and Stockport lead on to Liverpool.

At Doncaster matters are more complicated. No less than six other companies run in, these being the Midland and North Eastern, which have their own booking-offices on the platform, the Great Eastern, the Great Central, the Lancashire & Yorkshire, and the London & North Western. When Doncaster station was opened on the 11th of August 1848, the trial trip being walked by a train drawn by horses from there to Askern Junction, no one imagined that such a state of affairs was due in the future.

Coming up from the south is the Great Northern main line. At Black Carr Junction there runs in from the east the Great Northern and Great Eastern Joint from Somersham. At the South Junction comes in from the west the Great Central from Swinton, to leave on the east at the North Junction, that is Marsh Gate, for Grimsby. Farther north the West Riding Joint crosses at a right angle from Adwick to join the Great Central where the North Eastern line comes in from Hull. Just beyond this is Shaftholme Junction, where the North Eastern comes in from York; and a little farther on, bearing off to the west from Shaftholme, is Askern Junction, where the Lancashire & Yorkshire joins. Just outside Doncaster station, at North Junction, there goes off to the left the West Riding Joint,



THE GREAT NORTHERN RAILWAY

East Coast Joint Stock—First-Class Sleeping Carriage, No. 165

Extreme length, 56′ 6″ Extreme height from rail, 12′ 11$\frac{3}{8}$″ Carried on two 4-wheel bogies. Full length corridor. Pullman vestibules. Buckeye couplings. Steam heated. Electric lighting. Sleeping accommodation, 10 convertible berths. Attendant's pantry. Lavatory.

owned by the Great Northern and the Great Central, which leads to the Great Northern island in the Wakefield district, from which its trains get as far as Keighley which they enter on Midland metals. In fact Doncaster and Peterborough are the chief Great Northern junctions, and in the early days fierce was the struggle as to which of them should be the site of the locomotive works.

Boston was used temporarily to commence with, but was too much out of the way, and the final decision was in favour of Doncaster, as being nearer the coal and iron districts, and nearer the centre of the system in the plans of development at headquarters which were not destined to be carried out. The buildings were begun in 1853, and the works completed in 1854, the locomotive works being then near the station, the wagon works being at Carr, two miles down the line. Nowadays the works cover about 80 acres, and are surrounded by over 60 miles of sidings ; together with the station they occupy some 180 acres in a triangle by the banks of the Don.

For twenty-three years Doncaster was used for repairs only, all the engines being built by private firms. The locomotive department did not begin well. Benjamin Cubitt, from the South Eastern, was the first superintendent, but he died, before there was any track to run on, after ordering fifty of Sharp's standard pattern 6-wheelers to open the line with. These Little Sharps, as they were called, were 2–2–2's, with cylinders 15 in. by 20 in., driving wheels 5 ft. 6 in., leaders and trailers 3 ft. 6 in., boiler 3 ft. 6¾ in. by 10 ft., and heating surface 748 sq. ft. They weighed 18 tons 8½ cwt., and were afterwards fitted with equalising levers uniting the springs of the driving and leading wheels. Later on Mr. Sturrock converted some of them for Metropolitan work by lengthening the frames, adding a pair of trailing wheels and a tank and bunker.

The successor of Benjamin Cubitt was Edward Bury, the head of the engine-building firm at Liverpool, who at once ordered twenty engines from Hawthorns, and a dozen goods engines, six from his own firm and six from Fairbairns, these being coupled 4-wheelers, the first half-dozen having 5-ft. wheels, the wheels of the others being an inch larger. The Hawthorns were 2–2–2's, with cylinders 15 in. by 21 in., driving wheels 6 ft., trailers and leaders 5 ft. 6 in., heating surface 907 sq. ft., and the weight was 27 tons 1 cwt.

He bought four 4–2–0's that had been used by Peto in making the line, and he ordered a few more engines, including five saddle-tanks from his own firm; and in January 1850 he had about a hundred altogether working on 143 miles of the company's line and on 50 miles of other lines under running powers. But some of the shareholders did not approve of his double character of buyer and seller, and as the position was not satisfactory, a way out of the difficulty was found by his resignation.

In April 1850 the company advertised for a new superintendent, and out of 31 applicants the choice fell on Archibald Sturrock, Daniel Gooch's manager at Swindon, really the head of Swindon, for Gooch only put in an appearance there about once a month after it was in working order. Sturrock was born in 1816, and lived until he was well over ninety. During his apprenticeship at Stirling's East Foundry at Dundee he helped to build the Trotter delivered to the Dundee & Newtyle in March 1834, one of the curious engines of the Earl of Airlie type, with a rear bogie and 11 in. by 18 in. cylinders working straight upwards, with a connecting rod from the cross-head coming down the outer side of each cylinder to a bell-crank from which another connecting rod worked the driving wheels. After a time he had found his way to Gooch's engine-building enterprise that failed, or was about to fail, and when Gooch went to the Great Western he took Sturrock with him. Sturrock had luck, and he deserved it; it was his pride that he drove the first bolt for the first shed at Swindon and planned and built Doncaster. Another Great Western man went to the Great Northern at the same time; this was Seymour Clarke, the Great Western's London traffic manager, who was the first Great Northern general manager.

With two such men, both young, the Great Northern was in fine form for its London opening. Sturrock had seen at Swindon that what the locomotive wanted was a bigger firebox and greater boiler pressure, and he began by designing engines in which instead of 80 lb. he used 150 lb., but, acting on Brunel's advice, he kept it quiet, so that nobody took alarm. Before these were on the rail he had much overhauling and rebuilding of the old stock to do, and several engines to receive that had been ordered before he took over. Among these were ten Cramptons built by Longridge which were practically the same as the Folkestone belonging to the South Eastern, having inside cylinders and a dummy crank axle with outside cranks coupled to the large driving wheels near the firebox. It was one of these engines which took the first train from King's Cross at the opening of the London terminus in

A Suburban Train leaving King's Cross.

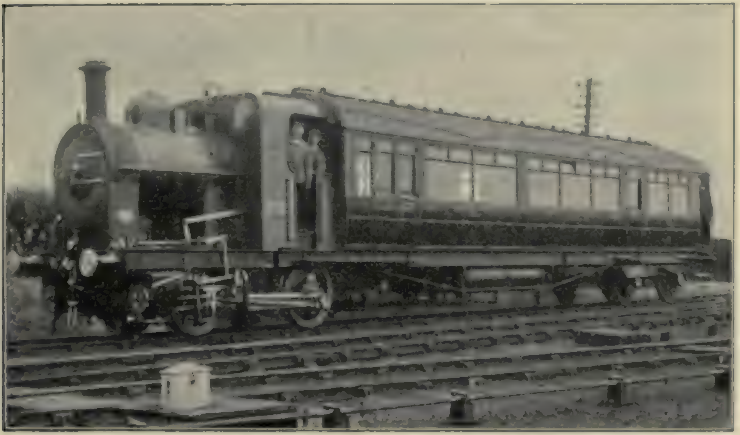
October 1852. Sturrock rebuilt the Bury and Fairbairn goods and added 3 ft. trailing wheels, fitting a tank and bunker so as to do away with the tender; and he converted the Cramptons, which lasted for years afterwards with 15 in. by 21 in. cylinders, 6 ft. 6 in. driving wheels, and 3 ft. 6 in. leaders and trailers, a heating surface of 972 sq. ft., and a weight of 28 tons 7 cwt.

Sturrock's first engine of his own design was No. 71. There were twenty of this class, all built by Hawthorns. Their cylinders were 16 in. by 22 in., they were 2–4–0's with 3 ft. 6 in. leaders and 6 ft. drivers, the boiler was 3 ft. 9½ in. by 10 ft., the grate area was 13·2 sq. ft., the heating surface of the firebox was 102, the total heating surface being 1006, and the pressure was 150 lb. These engines weighed about 28 tons, and were in many ways a great advance on their predecessors.

One of them drew the first royal train on the Great Northern. The first time Queen Victoria went by the line to Scotland was on the 27th of August 1851, when she went from Maiden Lane, then the London terminus, to Doncaster, and stayed the night at the Angel, leaving there before nine in the morning for York, to proceed by the York, Newcastle, & Berwick to Edinburgh. Beyond Stonehaven there were then no railroads, and from that principal port of Kincardineshire she had to drive all the way to Balmoral. In 1854 the journey was again made on the Great Northern, as it was every year after that up to 1861. The Prince Consort died in the December of that year, and ever afterwards the Queen went by the West Coast route.

Mention must be made of another class of handsome engines, the Large Hawthorns. These were of the 2–2–2 type, with 6 ft. 6 in. drivers and 4 ft. leaders and trailers, the cylinders were 16 in. by 22 in., the boiler was 4 ft. in diameter and of the usual 10 ft. in length, the heating surface 972, and they weighed 27 tons 16 cwt. One of them, No. 210, Oliver Hindley was driving down Retford bank when he saw a train going east from Sheffield to Lincoln which would meet him on the level crossing. He could not stop, and, making up his mind on the instant, he put on full steam and sent the Scotsman safely through the goods train, scattering the trucks into splinters, and causing no more damage to his own than the dents and scars on 210 which she carried with pride for many a day afterwards.

Also built by the Hawthorns was Sturrock's No. 215, an engine of the greatest importance, designed to run from King's Cross to Edinburgh in eight hours. She was put on the rail in August 1853, and was at once noticed as having a Great Western look owing to the absence of a dome, the shape of the firebox, and the curving of her frames over the driving axle. She had a leading bogie, being a 4–2–2, with driving wheels 7 ft. 6 in., bogie wheels 4 ft. 3 in. and 4 ft. 3 in. trailers, her cylinders were 17½ in. by 24 in., her heating surface, enormous for her date, was 1718, of which the firebox accounted for 155, and in working order she weighed 37 tons 9½ cwt. Powerful and fast,



A Rail Motor-Car (No. 2).

doing 75 miles an hour on favourable stretches, nothing but praise was ever given to this engine, but she was the only one of the kind, and though apparently behaving well wherever she went, she was withdrawn to Doncaster and never got to Edinburgh, the proposal to run such a train being postponed until there was more demand for it or for some other reason at present unknown.

Let us take her for the moment as being notable for her driving wheels; the next engines we must mention were notable for their leading wheels. These were the fine, powerful class Nos. 229–240, which cost £35,000 for the dozen. They were 2–2–2's, with 7 ft. drivers and 4 ft. 3 in. leaders and trailers, their cylinders were 17 in. by 22 in., the heating surface was 1060, and their weight was 34 tons 12 cwt. These engines had hoops on the crank jaws; and their leading wheels were the first that the Great Northern put immediately under the smokebox.

Crocodile Truck carrying a Stirling 8-footer fitted with a dome.

This engine record must now be shunted for a short space to clear the track for Sturrock's triumph. It had been arranged that the Great Northern should work their own underground traffic on the Metropolitan on and after the 1st of September 1863. That line had been opened in January of that year; it was laid with the mixed gauge in order that the Great Western trains might run through to Farringdon Street; and, as a matter of fact, all the trains were broad-gauge worked by Great Western engines designed for the purpose by Daniel Gooch, with tanks below the boiler barrel into which the exhaust steam went so as to keep the tunnels workable. They were suitable engines, 6-wheelers with coupled 6-ft. wheels, and they were tastefully named the Wasp, the Bee, the Gnat, and other entomological things, the later ones being named after flowers—flowers and insects being so characteristic of the pre-electrical underground.

First-class Dining Car.

From the first the Great Western seemed to look upon the line as their own private property, whereas Mr. Myles Fenton, the Metropolitan general manager, thought otherwise, and the result was unpleasantness that culminated in a storm. The Great Western people, thinking they had him at their mercy, gave him summary notice that in ten days' time, that is on the 9th of August 1863, they should withdraw their rolling stock and leave him without any engines or carriages to work his line with. They had mistaken their man; and they had not thought of Mr. Sturrock.

Fenton hurried off to King's Cross and Euston and told the story, and the Northern and the North Western at once offered to help him so far as carriages went, but with regard to engines it was a different matter, for the Metropolitan's Act forbade any being used on the line that did not consume their own smoke and condense their own steam. In preparation, however, for the 1st of September, Sturrock had ready a few he had specially built and he turned all Doncaster on to adapt others. "They shall be ready on the 9th," he promised.

By flexible pipes—which frequently burst—he led the exhaust steam from the engine into the tank of the tender, utilising old engines for the purpose that had not been in steam for years, and as soon as the broad-gauge trains had left the tunnels for the night the Northern engines were on the rails being experimented with for hours. But it was all kept as quiet as possible ; on the 8th Paddington waited in vain for the surrender that never came ; and on the night of the 9th, as the last broad-gauge train left King's Cross (Metropolitan) on its westward journey, there came down that tunnel on the north side train after train, Great Northern or North Western, all drawn by Sturrock's engines, most of them by Sturrock's adaptations, which managed to do the work until the Metropolitan's own engines, built at top speed by Beyers, came to relieve them. It was "the man that came from Swindon" who turned the broad gauge out of London ; though the Windsor to Paddington through service of only a few trains lasted for another five years.

It was Mr. Sturrock who endeavoured to make the tender something more than a dead weight by fitting it with an auxiliary engine. He coupled its wheels, put in a crank axle, and worked this by cylinders hung underneath the body which received their steam from the boiler. These "steam tenders" were used on the coal and goods trains for some time, and are reported to have been efficient but too costly in working and repair to be continued with. His last engines were Nos. 264–269 ; these were of the 2–4–0 type, with 7 ft. drivers and 4 ft. 3 in. trailers, the cylinders were 17 in. by 24 in., and the heating surface was 1028.

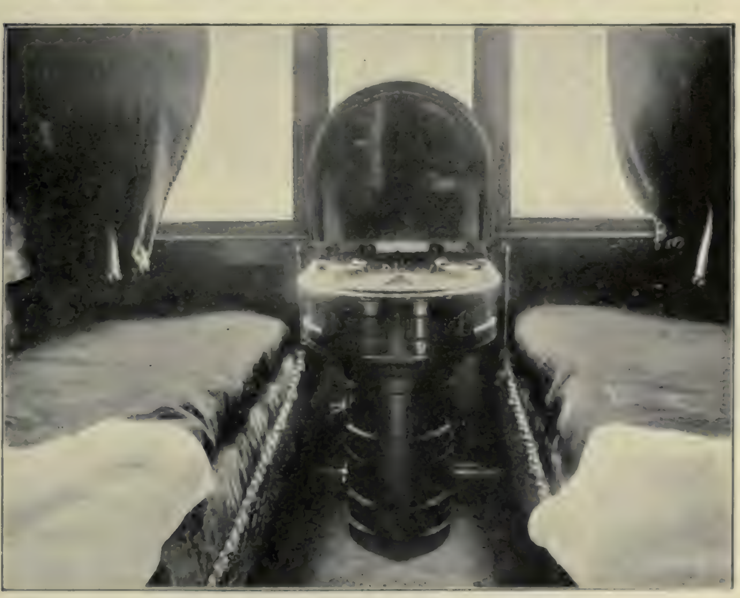
The next chief at Doncaster was Patrick Stirling, who was born at Kilmarnock in 1820. He began at Dundee, then he went to the Vulcan, then to Neilsons, then he was locomotive superintendent of that very little line the Bowling & Balloch, then he was at Hawthorns, and in 1853 he became locomotive superintendent of the Glasgow & South Western, spending thirteen years in his native place before he moved on to Doncaster, to remain there in command for twenty-nine years.

Dining Saloon of the East Coast Express.

He had ideas of his own about railway engines, and he built the best looking that were ever put on the rail. That being a matter of taste, it cannot be disputed. There is no mistaking a Stirling engine. There is nothing clumsy about it. Graceful and powerful, and above all things workmanlike, with nothing spoiling the beauty of its lines, it is the very embodiment of speed. It is perfectly proportioned; nothing is unduly developed; there is no feature that is too large for its position. His engines came at that happy period when the power that was wanted was exactly such as could be provided by a machine in which no detail had to be unduly prominent, though even then there were things on the rail such as provoked old Beyer's exclamation, "Ach, anything vill for a locomotive do!"

His first Great Northern engine was No. 280, one of a class of twenty whose numbers ended with 299. This was a 2–4–0, with 6 ft. 7½ in. drivers and 4 ft. 1½ in. leaders, the cylinders were 17 in. by 24 in., the boiler—mark the increase—was 3 ft. 10½ in. by 17 ft. 9 in., the heating surface was 1085, and the weight was 34 tons 9¾ cwt. The same year, 1867, he built the first engine at Doncaster; she had 5 ft. 7 in. wheels, and was a 0–4–2. Next year he began building his singles, 2–2–2; their driving wheels were 7 ft. 1 in. Then he began to consider about No. 215, which stood among the doomed in Doncaster yard. It seemed to him such a pity to break up those magnificent wheels that he decided to use them, and, what was more, to design an engine that would show what they were capable of. Thus it came about that he built No. 92, an engine 23 ft. 9½ in. over buffers, with 17½ in. by 24 in. cylinders, and leaders and trailers of 4 ft. 1 in. Tried in all ways, this engine did so well that he was led to think of bigger wheels, and thus evolved his first 8-footer.

The direct line from Doncaster to York through Shaftholme was about to be opened, and there was to be an acceleration of speed on the East Coast route. Some such engine was wanted; and it came out in 1870, the year of the opening. So successful was the new engine that so long as he remained at Doncaster, that is for the rest of his life, his 8-footers did the express work of the main line. They were the Great Northern engines, and the public knew no other although there were others, nearly a thousand of them, in twelve classes, ancient and modern, and these were only forty-five. They did not remain quite the same during the quarter of a century and more they needed no pilot, and Mr. Stirling would never allow two engines on any one train. There were, of course, changes in detail in strengthening parts, augmenting surfaces, and adding to grate area to give increase of power, but these were too slight for us to trouble about here.



A Double-berth Sleeper on the Far North Express.

They had outside cylinders, and these were 18 in. in diameter with a 28-in. stroke, and the driving wheels were 8 ft. in diameter, that is nominal, none being smaller, though some of the wheels, when new, measured 8 ft. 1½ in. The tractive factor was thus 93, but so far as tractive effort is concerned it should be remembered that such wheels with such a length of stroke were equal to 7 ft. 6 in. wheels with a 26-in. stroke, or 6 ft. 10½ in. wheels with a 24-in. stroke. These huge wheels made 210 revolutions a minute, and the piston speed was 980 ft. a minute, that is at 60 miles an hour.

The boiler was 4 ft. 2 in., that is 4 ft. in internal diameter, and it was 11 ft. 6 in. in length. Within it were 174 copper tubes of 1¾ in. diameter, giving ample water space and a heating surface of 936 sq. ft. The length of the casing was 6 ft. 2 in. There was no dome, the steam being collected by a perforated pipe running along under the top of the boiler as in No. 215. The firebox had a heating surface of 109 sq. ft., making 1045 altogether, and the grate area was 17¾ sq. ft. The firebox crown was tied to the outer shell by screwed stays, and the end plates were fixed to the barrel by diagonal stays. The feed-water came from the tender through two injectors, entering the back-plate and led to the centre of the barrel by an internal pipe. The pressure was kept within 170 lb. by Ramsbottom valves. The blast pipe was 4¾ in. in diameter.

The trailing wheels were 4 ft. 6 in., those of the bogie measured 3 ft. 10 in., but these dimensions varied somewhat. The bogie pivot was placed behind the centre, there being no transverse movement. The engine measured 29½ ft. over buffers, and had a wheel base of nearly 23 ft. In working order it weighed 45 tons 3 cwt. The tender had six wheels, and with its 15½ tons of water and 5 tons of coal weighed 40 tons 5¾ cwt., so that the weight of engine and tender combined was 85 tons 8¾ cwt.

It was during the race to Edinburgh in 1888 that those who had not travelled by the Great Northern learnt what these engines could do. On the 1st of November 1887 the East Coast partners had begun carrying third-class passengers by their 10 a.m. train from King's Cross to Edinburgh, which did the distance in 9 hours, while the West Coast trains, which carried third-class, did it in

10 hours. The effect of the alteration was that the West Coast found their third-class bookings to Scotland seriously diminishing. As matters became worse the West Coast replied by reducing their time from 10 hours to 9 on the 1st of June 1888. Needless to say the East Coast people, who had been having an easy time of it, revised their time-table for the following month, and by knocking off a quarter of an hour between London and York, and another quarter from York northwards, ran to Edinburgh in 8½ hours.

This woke up the West Coast partners, who placarded Euston on the 27th of July with bold advertisement that on the 1st of August they would deliver their passengers in 8½ hours, and they did it. But the four days' notice was fatal, and, the very afternoon the posters appeared, King's Cross and York took counsel together, with the result that the day the West Coast reached Edinburgh in 8½ hours the East Coast was there in 8. Thereupon the West Coast arranged to be there in 8 hours, beginning on the 6th of August, and they got there eight minutes before time, but with four carriages only, while the East Coast were punctual with their ordinary load, which was much heavier, but not double as heavy, though their carriages were twice as many. This dead heat business was not good enough for the East Coast, and so on the 13th of August they reduced their time by a quarter of an hour, after due announcement, which gave the West Coast a chance to do their very best and get there in 7 hours 38 minutes. Next day the East Coast replied by keeping time at all their stopping stations, as if nothing out of the ordinary was on, and reaching Edinburgh in 7 hours 32 minutes. That settled the matter ; there was no more racing after that ; and the result of it all was that the East Coast instead of getting to Edinburgh in 9 hours went there in 7¾ hours, and the West Coast instead of taking 10 hours took 8 hours, for which every one going north was duly grateful.

The Great Northern engines took the trains to York, and the North Eastern engines continued the running to Edinburgh. All through the month the Scotsman stopped at Grantham for one 8-footer to relieve another. From King's Cross to Grantham is 105 miles 26 chains, and the average of speed was 55·7 miles an hour. From Grantham to York the distance is 82 miles 55 chains, and the average speed was 55½ miles an hour. Thus the whole distance to York, 188 miles 1 chain, was traversed for 31 days at 55·6 miles an hour; and it was the right sort of average, the daily differences being only in the decimals. It was this unvarying excellence that distinguished the 8-footers; it did not seem to matter which of them was put on, they could always be trusted to do the work that was given them. And seven years afterwards in the race to Aberdeen they were called upon to do better than they had done in the race to Edinburgh.

In June 1895 the East Coast were taking their 8 p.m. train from King's Cross to Aberdeen in 11 hours 35 minutes, when the West Coast announced that to make sure of a connection with the Great North they would quicken their 8 p.m. train so that it should reach Aberdeen in 11 hours 40 minutes, just five minutes behind the other.

The East Coast took this as a challenge, and replied by knocking off a quarter of an hour from the journey on and after the 1st of July. As Aberdeen was a Caledonian preserve which the North British only entered by running powers on the Caledonian from Kinnaber Junction, 38 miles 22 chains to the south, there was nothing surprising in the West Coast hastening to reply by arriving there on the 15th of July in 11 hours; but it was a foolish thing to do as the East Coast route was by 16 miles the shorter.

At the end of a week the East Coast altered its time-table and proposed to be there in 10¾ hours. Then quite a new policy was adopted by the West Coast. Bearing in mind what had happened in the race to Edinburgh, they ignored their time-tables altogether and, treating the train as a private special, they concentrated their efforts on accomplishing the journey in a shorter time than their rivals, irrespective of their announcements, so that in the end their train booked to reach Aberdeen at 7 a.m. was actually there at 4.55. The East Coast were some weeks before they fully grasped what their opponents were doing; and it was not until the 19th of August that they really began to race in the longest railway race that ever took place in these islands.

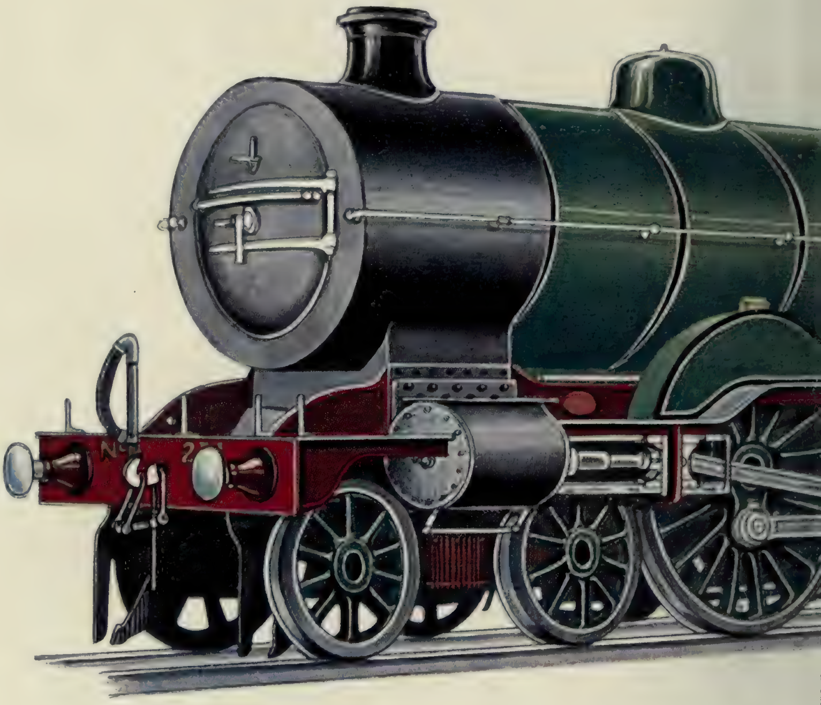
The Tea Room at King's Cross.

It was on the 16th of August that the East Coast announced that on and after the following Monday their train would take 9 hours 40 minutes on its journey, this being 19 minutes better than the West Coast had done up to then. Great was the excitement that

Monday night at both Euston and King's Cross. The 8 p.m. North Western went off amid cheers to reach Aberdeen according to the time-table at 7 a.m., and according to intention to throw time to the winds and get there as soon as it could. At King's Cross this was understood, but it was even then not understood at Edinburgh, and when the Great Northern train arrived there nine minutes before its time the North British stationmaster refused to allow it to leave the station until the very moment it had been booked to do so.

It had lost two minutes by checks at Hatfield, Welwyn, and York, and five minutes by a signalman's error at Eryholme, and these it had made up; and when it reached Dundee it was again stopped for six minutes because it was before time. Thus it came about that the West Coast was first past Kinnaber. The North Eastern and the Great Northern forcibly protested against the treatment of the train at Waverley and Dundee, and with great difficulty managed to drive the idea into the head of the North British; and next night the train left Edinburgh as soon after its arrival as the passengers could be got in and the North British engine put on. The North Britishers did their duty well, and Dundee was as quick as Waverley, but, as the East Coaster passed Montrose, away in the west could be seen the steam of the rival which by less than a minute got the line clear at Kinnaber and led the way to Aberdeen.

This would never do for the Great Northern, and, with No. 668 in front, as on the Monday and Tuesday, the train out on the 21st of August meant real business. Peterborough, 76¼ miles, was passed in 72 minutes; Grantham, 105¼ miles, was reached in 101 minutes. Another 8-footer, No. 775 as before, came on, and York, 188 miles, was reached in 181 minutes, including the Grantham stop. There North Eastern engine No. 1621 took over for the run to Newcastle, there to be relieved by No. 1620, which



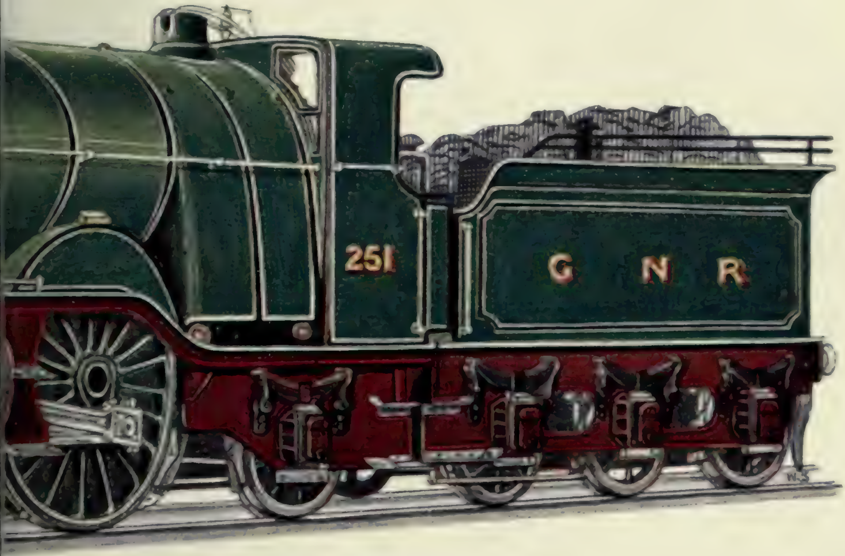
THE GREAT N

EXPRESS PASSENGE

DESIGNED BY MR. H. A.

BOILER	Length	16′ 0″	**FIRE BOX**	Length	6′ 6″
	Diameter	5′ 6″		Width	6′ 9″
CYLINDERS	Diameter	19″	**HEATING SURFACE**	Tubes	2359 sq. ft.
	Stroke	24″		Fire box	141 ,,
TUBES	No.	248			

PLATE 24



THERN RAILWAY

LOCOMOTIVE, No. 251

TT. M.INST.C.E., M.INST.M.E.

DIAMETER OF WHEELS		
	Bogie	3′ 8″
	Coupled	6′ 8″
	Trailing	3′ 8″

GRATE AREA . . . . 31 sq. ft.

WORKING PRESSURE 175 lb. per sq. inch.

WEIGHT IN WORKING ORDER		Tons.	Cwt.
	Engine .	68	6
	Tender .	40	18
	Total . . Tons	109	4

WATER CAPACITY . . . . 3670 galls.

COAL CAPACITY . . . . 5 tons.

went at an average of 66 miles an hour to arrive at Waverley, 124½ miles, on a record trip of 6 hours 19 minutes from London. The North British No. 293 replaced her for the stretch to Dundee, and thence the other North Britisher, No. 262, thoroughly awake this time, was on and away and, splendidly driven, swung into Aberdeen at 4.40, no less than 14½ minutes ahead of the West Coast, which had also done its fastest run. That 60 miles an hour from start to finish, with 3½ minutes to spare, was the end of the racing.

The Kitchen of a Restaurant Car.

The time that settled the matter was not, however, the shortest, for on the following night, that of the 22nd of August, the West Coast train, cut down to its lightest, made "an exhibition run" and accomplished the journey in 8 hours 32 minutes, being 8 minutes less. Throughout the contest the East Coast carried the heavier load; on the 19th this consisted of six large E.C.J.S. coaches and

A Car Attendant.

an 8-wheeled sleeper all the way, and on the 20th and 21st it was these 7 for 393 miles and one short for 130 miles. The West Coast load on all three days was six coaches for 450 miles and 4½ for 89 miles, while on the exhibition trip the load was only 68 tons, there being but three coaches. The East Coast engines were two Stirlings, two North Eastern 7-ft. coupleds, and two North British 6 ft. 6 in. coupleds. On the West Coast the 7-ft. compounds Coptic and Adriatic, between Euston and Crewe, and the Precedents Hardwicke and Queen between Crewe and Carlisle shared the duty between them ; between Carlisle and Perth the Caledonian used No. 90, a 6 ft. 6 in. coupled, and between Perth and Aberdeen No. 17, a new 7-ft. single.

As it was at Edinburgh and Aberdeen, so it had been at Manchester in 1857, when the rival trains used to race to London Road Junction and the first to get there had the right of way. In this case the Great Northern were the partners of the Manchester, Sheffield, & Lincolnshire, and the competition became so keen that the North Western actually took people into custody for coming by the Sheffield trains, until they arrested a lawyer who made them pay for their exuberance and put a stop to it.

According to Mr. Denison the M. S. & L. had painted up their names, and the North Western " being in possession, which is nine points of the law, swept them out with their brush. They kept a truck standing in front of the platform, and left timber trains in front of our express trains. They turned our clerks out of the booking office—indeed they nailed up the part which the Sheffield Company had been accustomed to use—and when one of the clerks, acting under instructions, made his way in through the window, they ejected him by the same way, not I hope, wrote their solicitor, with unnecessary violence."

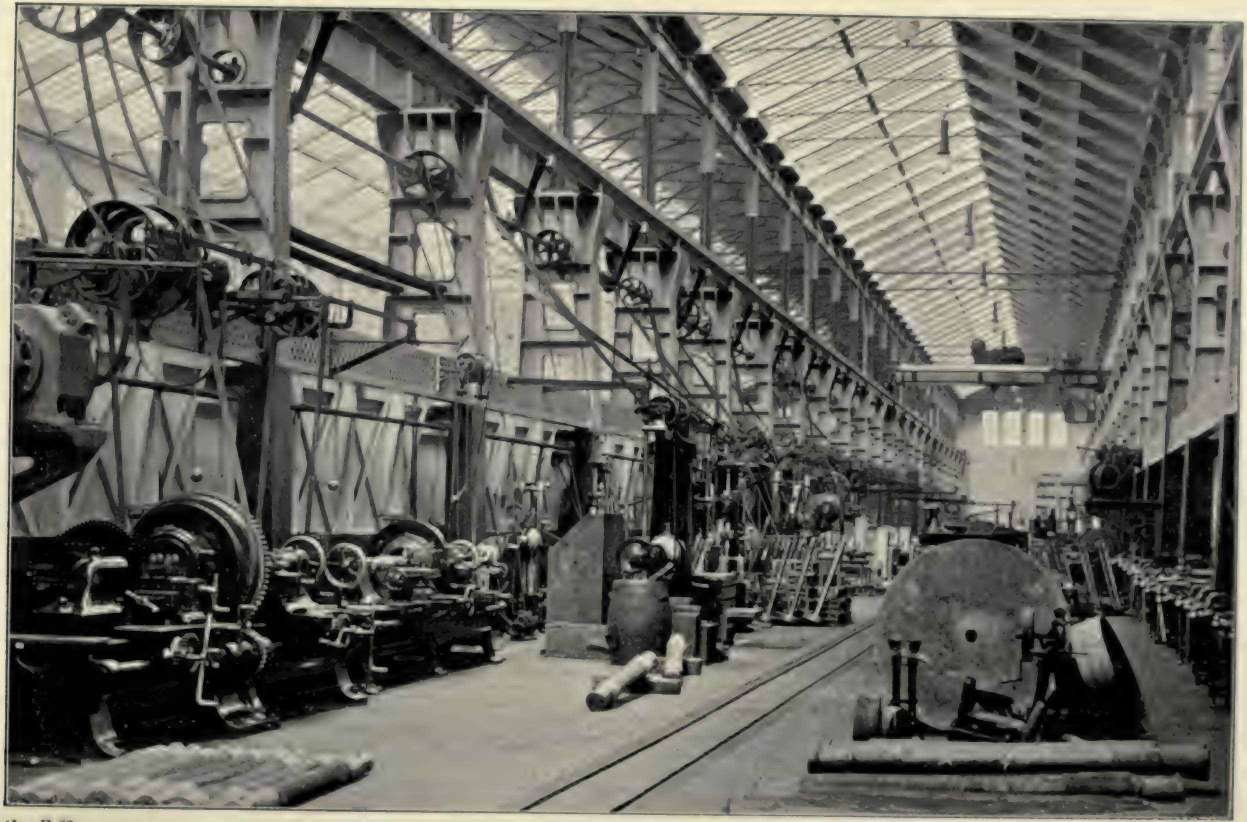
The Main Line Arrival Platforms, King's Cross.

This was only one incident in a war of rates and sundries which ended in the partners running to and from London the best train known in England. By this train, faster than the Scotsman, the King's Cross route to Manchester, 203 miles, was travelled in quicker time than the North Western's 189 and the Midland's 191¾, and this over the trying gradients from Grantham onwards. But from

Grantham the work was that of the partner now known as the Great Central.

Another incident of which some mention should be made was the arrival of the first Great Northern engine at Nottingham on the 1st of August 1852. The Northern engine had brought in on the old Ambergate line a train of passengers from King's Cross when the Midland resolved to seize it. Accordingly several Midland engines were manœuvred about until they converged on it in front and rear, and though the driver did all he knew, the Great Northern engine was hauled and pushed, and finally pushed slowly and ignominiously into a disused shed, where the rails at the entrance being pulled up it remained a prisoner for seven months while the lawyers argued the matter out, to the inevitable result that as the engine had a right of entry it had a right of departure; and the Northern has gone to Nottingham ever since.

In the autumn of the race to Aberdeen Mr. Henry Alfred Ivatt, the locomotive superintendent of the Great Southern & Western (who had received his professional training on the London & North Western) was appointed chief at Doncaster. He took up his new duties in March 1896, and at the latter end of that year brought out his first engine, No. 400. This was the first 4-coupled bogie tender engine the line had seen, and had inside cylinders 17½ in. by 26 in., driving wheels 6 ft. 8 in., and a boiler 4 ft. 5 in. in diameter, with 1123 sq. ft. of heating surface, 17½ sq. ft. of grate area, and 170 lb. working pressure; and it was fitted with a steam dome. This was another innovation so far as the line was concerned, and the superiority of the engines fitted with dome boilers soon became manifest, especially when some of the 8-ft. Stirling engines were fitted with a dome and with boilers having larger fireboxes. The 400 class (many of which were subsequently built) were so successful that in 1898 Mr. Ivatt brought out some similar engines, fitting them with



DONCASTER WORKS—THE MACHINE SHOP

larger boilers of 4 ft. 8 in. diameter, having a heating surface of 1250 sq. ft. and 20 sq. ft. of grate area. The first of these engines was numbered 1321 ; and at the time of their introduction this class carried the biggest diameter of boiler running in England over 6 ft. 8 in. wheels.

The heavy corridor stock which was being introduced in the chief express trains frequently necessitated the use of two engines on a train, and to curtail this expensive method of haulage Mr. Ivatt brought out, in 1898, a type of express engine which had not been seen on British railways before. This engine (No. 990) runs on 10 wheels, and is of the well-known 4–4–2 or Atlantic type. The outside cylinders are 18¾ in. by 24 in., the coupled wheels 6 ft. 8 in. in diameter, the bogie and trailing wheels being 3 ft. 8 in. in diameter. The boiler was considered very large at that time, being 4 ft. 8 in. in diameter, and having 1442 sq. ft. of heating surface, 26¾ sq. ft. of grate area, and 175 lb. working pressure ; and the engine weighed in working order 58 tons. Several of these engines were subsequently built at Doncaster and are doing very good work.

Owing to the ever increasing weight of the fast trains, and the demand for high speed for long distances without stopping, Mr. Ivatt designed and built at Doncaster in 1903 an engine of the same dimensions as 990 but fitted with a much larger boiler, the diameter of the barrel being 5 ft. 6 in., with a heating surface of 2500 sq. ft., whilst the grate area was 31 sq. ft. The most remarkable feature of this boiler was that the firebox, instead of being long and narrow, fitting between the frames, as is the usual practice in this country, was shorter and wider, spreading over the frames. This type of firebox increases the evaporative efficiency of the boiler, and has proved itself thoroughly satisfactory in producing an economical and efficient locomotive. Owing to the large diameter of the boiler it is of necessity placed high up so as to clear the driving wheels, which has caused the use of a short chimney on account of the restrictions of the loading gauge, and imparted to the engine a massive, powerful appearance, compared with the more slender and graceful outline of its predecessors. The Atlantic type, of which many have since been built at Doncaster, are now the standard for the express work of the line, and when in working order weigh 68 tons, whilst the tender fully loaded with 3500 gallons of water and 6 tons of coal weighs 43 tons.

In 1905 the directors decided to ascertain whether any of the locomotive builders could supply an express engine suitable for the conditions on the Great Northern and capable of doing better work than those already on the line. The engine proposed by the Vulcan Foundry, Newton-le-Willows, was accepted, and No. 1300 was designed and built by that firm. This engine is a 4-cylinder balanced compound, and has outside high-pressure cylinders 14 in. by 26 in. and inside low-pressure cylinders 23 in. by 26 in., coupled wheels 6 ft. 8 in., heating surface 2514 sq. ft., grate area 31 sq. ft., and boiler pressure 200 lb. per sq. in., and it weighs 71 tons in working order. In 1906 some exhaustive trials were carried out between this engine, the Doncaster 4-cylinder compound No. 292, and one of the standard Atlantics, No. 294; and the result did not indicate that it would be to the company's advantage to have engines of the 1300 type in preference to those already working their express trains.

The development that has taken place in locomotive building was clearly shown in the 1909 Exhibition at Shepherd's Bush, where, side by side, stood Mr. Stirling's first 8-footer No. 1, built in 1870, and Mr. Ivatt's Atlantic No. 1442, built in 1908. The former engine had run 1,400,000 miles before being taken from the track for good; the latter had run 45,000 miles before coming to her temporary rest by the side of her predecessor; and each engine stood on a length of permanent way of the kind in use at the time she was built, thus illustrating the increased strength of rails, etc., to meet the increased weight. So bright were they that they acted like mirrors in which the reflections from everything around in the sunlight gave them the curious appearance recorded in the annexed photograph, of which the dome of 1442 is the most remarkable feature. "Well," said one of the crowd, "they do know how to shine them up at Doncaster."

Doncaster was an excellent place to be shown the sights at some years ago, and it is so still. It is not too large, and there was plenty of daylight in the shops. There was the massive lathe for turning the big driving wheels with its face-plates 8 ft. 10 in. in diameter, and as you looked at it you could not help thinking of the splendid subject for a picture, which nobody thought it worth while to paint, of the group of stalwart smiths, with their sledges going, knocking up the wrought-iron wheels the lathe was built to turn. There was the crank-shaft lathe with its fast and slow speed at each revolution, the slow while

Interior of Loversall Carr Signal Box.

the metal was under the tool, the fast swinging it round to bring it under the tool again. There were buffers being made, a glowing sphere with a shank to it dropped shank downwards into a mould with the shank protruding through the hole, then the top of the mould put on, then the half-dozen blows under the hammer to flatten the red-hot ball into shape, then the cutting off of the fringe squeezed out, and then the welding on of more shank and the foot. And there was the building of the engine upside down, the frames being placed on the blocks with the underside uppermost, bolted in position, motion-plate, buffer beams all attached, horn-blocks put on, axle-boxes fitted and removed, and then the cranes that lifted it sideways and put it right side up. Engines there were, old and new, in all stages, in the shops and on the sidings, and not so much of a rotten row as usual. There is a reason for this, for every September there is such a clearance as is elsewhere unknown.

It is the St. Leger—pardon, the Sellinger—week, when the works are closed not so much to give the men a chance of going to the races, which many of them do not, but because every inch of siding is wanted for the excursion traffic. Those who would know what race traffic is like, and how to manage it, should go to Doncaster. They need not travel up to the moor unless they wish to, they can do as others have done during the interval between the arrivals and departures, look about and rest and refresh themselves with, among other things, a packet of butter-scotch bought at the shop where during the four days they say they sell 14 tons of it. Fourteen tons of butter-scotch! If, as we are taught, total abstainers are distinguished by their fondness for sweets, what a lot of teetotalers must go to the Sellinger!

To begin with, all the sidings are cleared and no goods train is allowed on them during the four days except for an hour or two in the dead of night. The block sections are divided into halves by temporary signal-boxes, and the tracks are all numbered so that any one may know them. Into the station go the ordinary trains, with their duplicates and reliefs and certain private specials; into the sidings go the excursions. In the locomotive sidings are the Lancashire & Yorkshire and Hull & Barnsley trains; the North Eastern and Midland share the down goods yard; the Great Central are in the St. James's Bridge sidings; the Great Northern, North Western, and Great Eastern occupy the Shakspeare sidings.

A Signal Gantry—Red Bank.

As each train arrives to take up the exact position marked out for it, each of its passengers is given a printed notice telling him the number of the train, which is conspicuously placarded, the position of the train on the sidings, and the way to reach it, and also the time of its departure, which is kept to the minute. The place is like a vast showyard with its big numbers and notices and the handbills in the people's hands. From north, south, east, and west the trains run in, and every engine stops at its mark, and then from its carriages pour its five hundred or more, perhaps its thousand, passengers to stream into the throng that is on the way to the moor.

The first departure is at a quarter to six, and long before then the early trains have begun to fill. Larger and larger grows the hurrying crowd that swarms all over the tracks, almost every man with his handbill in his hand. To the minute off goes the first train, and, at intervals so short that there is not a moment in which a train cannot be seen on the move, off go the others in succession, diverging in six different directions. In one week, we may as well be exact, there were 49 excursions on the Tuesday, 173 on the Wednesday, 47 on the Thursday, 69 on the Friday; and on each of the four days there were some 180 trains worked from the station. These 1065 trains in the four days move off like parts of one machine, there is no slowing or stopping at the points, once a train begins to move it goes on faster and faster until it is out of sight; and they scatter to every point of the compass without a check. If you want to see what can be done by organisation taught by years of experience, go to Doncaster on the St. Leger Day.

Next to Doncaster the most important junction on the line is Peterborough, which is the real centre of the system. Every day there pass through that station over a thousand trains, passenger and goods, of which about three-fourths belong to the Great Northern. It is the great transhipment station of the company, just as Crewe is the transhipment station of the North Western.

Peterborough has 50,000 wagons on its books for merchandise, bricks, coals, iron, and cattle. For the cattle there are the docks by the side of the line that pass in and out some 65,000 head a year, and generally look as though used but once before they are whitewashed. South from it stretch the Fletton brickyards, where bricks are made by the million, every million weighing 2400 tons. Of coals there come to Peterborough 10,000,000 tons to be distributed. To marshal all these wagons there are the New England sidings, where there is standing room for 5000 of them at a time. There are sixty tracks side by side, and looking across them when they are busy is like looking over a vast lake of coal. Here and there you see some of the new 15-tonners and 20-tonners, excellent things when they are on the run, but difficult to get into many collieries, and impossible to get into most, owing to the screens and weighbridges being of the standard 10-ton size. The names on the wagons tell of coal-pits by the dozen and coal-merchants by the hundred, and as hardly anybody orders a train of coals you wonder how all those wagons are arranged in order for distribution. It is at New England that most of this work is done, and those who would know how trains are "marshalled" will

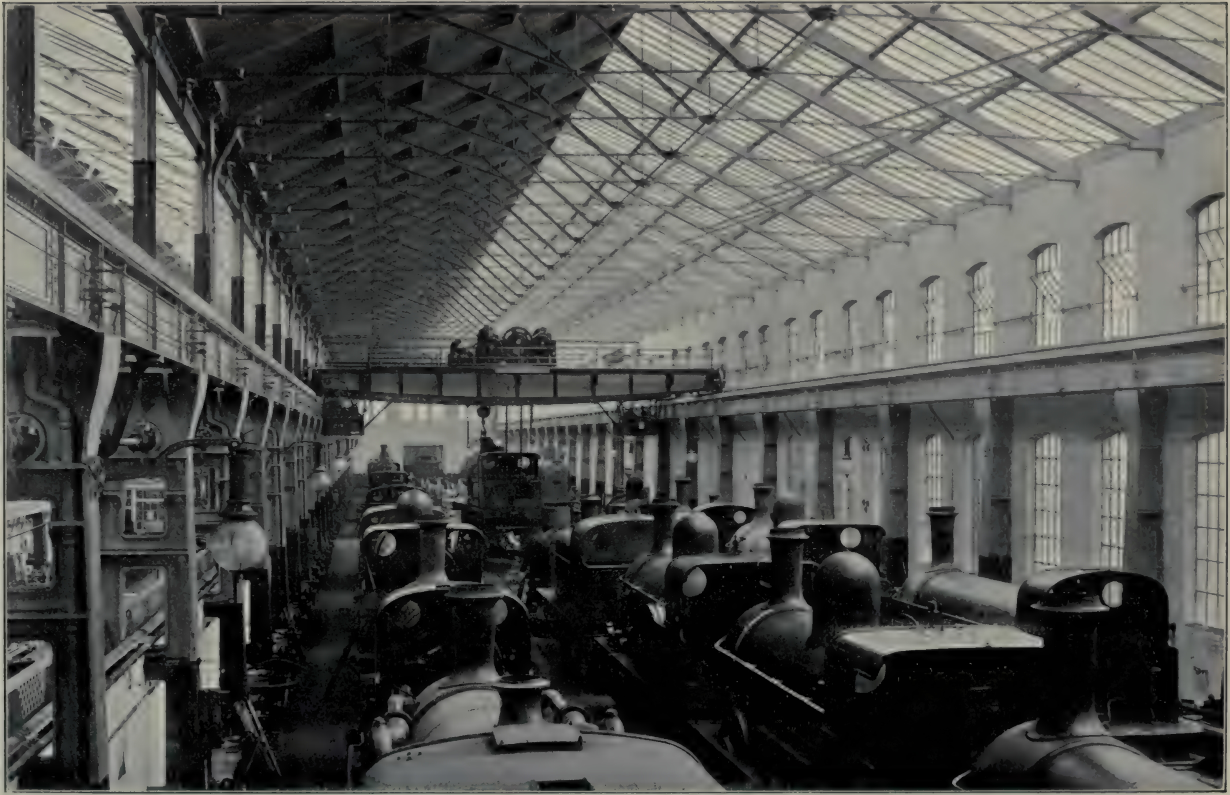
The Digswell Viaduct at Welwyn.

find it described in detail in the sidings chapter of *Everyday Life on the Railroad.*

At Peterborough the Great Northern has its sheet stores. Here all the tarpaulins, wagon covers, dray covers, and ropes are made, 35,000 sheets being kept in stock and 300,000 yards of canvas used in a year. Hundreds of tons of boiled linseed oil are annually absorbed, and by no means so much by weight of vegetable black, which is one of the lightest things you can lift, but let us say a suitable measure of it. The sheets are laid out on the floor like well-made, stoutly sewn carpets, and the colour is laid on with brooms, not one coat but five, and when the surface is good enough to pass muster there are run across it the white-and-blue diagonals reminiscent of St. Andrew, for every railway has its distinguishing mark, and then come the initials and the number, for sheets are recorded at the Clearing House as carefully as wagons and, like them, are subject to demurrage.

The 50,000 wagons on the Peterborough books are largely in private ownership, the whole of the wagons and coaches belonging to the company numbering about 43,000, the engines, which travel about 23 million miles a year, being about 1300. These deal with some 5 million tons of miscellaneous merchandise and 16 million tons of coals and other minerals. The passengers are about 37 millions yearly, and the line is 850 miles long; but, as we have already shown, it is of much more importance than its mileage would indicate. In one respect the Great Northern differs from all our great railway companies. It has no steamboats; but it has docks at Boston, and leases the Nottingham Canal that was made in 1792 and the Grantham Canal that was made the year after, besides the Witham, and a half share in the Fossdyke which was made by the Romans and enlarged in the reign of Henry the First, and is the oldest canal in England.

When the line was opened it introduced the best third-



ENGINE REPAIR SHOP—DONCASTER WORKS

class coaches that had been seen. They were equal, it was reported, to those of the second class on most other lines. In truth the Great Northern has always been well to the fore in its passenger accommodation. In November 1879 it put the first dining-car on the rails between London and Leeds, and since then it has kept abreast of the north-going companies in every increase in the length and weight of its coaches, and every advance in luxurious furnishing, including single and double sleeping cabins for the night journey to the north. On the other hand, to deal with the heavy suburban traffic and the growth in the length of the trains, it has adopted the economical Great Eastern policy of broadening the third class in order to seat six aside.

The ordinary express coaches are 64 ft. long ; those of the East Coast Joint Service are 65½ ft. ; and the King's Saloon of the Royal Train is 67 ft. This is a complete little flat on wheels, designed so as to give a wonderful amount of accommodation. Carried on two 6-wheeled bogies, it is 12 ft. 11 in. from the rail level and 9 ft. in width. The entrance doors are double, and the windows are of bevelled plate-glass balanced so that they can be easily adjusted to any required height. Entrance balcony, smoke-room, day-saloon, dining-room by day or bedroom at night, dressing-room, and attendant's compartment, come in due order.

The body is of teak. The smoke-room, 10 ft. long, is lined with oak inlaid with boxwood and dark pollard oak, the furniture being two arm-chairs and a settee upholstered in reindeer, the fittings being of oxidised silver. The day saloon, 17½ ft. long, is lined with sycamore inlaid with trellis lines of pewter and light mahogany, the furniture being of light mahogany inlaid with pewter and box upholstered in silk brocade, and it consists of two arm-chairs, a settee, four smaller chairs, and a writing-table. Both smoke-room and day-saloon are lighted by rows of tubular electric lamps concealed behind the cornices on each side, giving a soft and restful illumination, increased when desired by the silk-shaded bracket lights in the corners. The bedroom, or dining-room, is 14 ft. long, and the walls are panelled and enamelled white, the furniture being in mahogany inlaid with kingwood and covered with old rose-coloured silk damask with green silk embroidered cushions. When used for day journeys the bed is taken out and the compartment is converted into a dining-room, as shown in the illustration. The attendant's room is fitted up with electrically heated kettles and so on, and the switchboard by which the lighting and heating of the carriage are controlled; for, in addition to the electric radiators, the saloon is heated by warm air delivered into the various compartments through ducts from electric blowers, ventilation being worked in the same way, the air being extracted by electric exhausters. The Great Northern and North Eastern never allow you to forget that they are partners. The King's carriage was built at Doncaster; the Queen's carriage, equally elaborate, was built at York.

Among the "wagons of all kinds not used for passengers" the longest would seem to be the so-called "crocodile" trolley on which Doncaster puts an engine and carries it about as if it were a toy. A motor-car looks bad enough on a dray, but then we are used to it, but an 8-footer on a truck must be left to speak by its portrait. This is, of course, only one of many special vehicles required in the varied work of our railways, of which even a list would fill a page or two. What with cattle and meat and milk, and rabbits and poultry, and pigeons for flying and quails for eating, and fish-trucks you take the body off and sling on to a horse-trolley for Billingsgate, and trucks for plate-glass and timber and guns, and the crowd of others including the two extremes, refrigerator vans for keeping things cool and banana vans for keeping things warm, to say nothing of the motor and horse vehicles, the wagon designer of to-day cannot complain of monotony.

Railway companies do not make so much money as they did, nor are they likely to do so. Corridor cars, catering cars, and so on, are all desirable for non-stop runs, but they cannot be worked cheaply. Up to about 1890, when the coaches were 6-wheelers, the train weighed 120 tons; during the next ten years the coaches became 8-wheelers and the train increased in weight to 200 tons; now the coaches are 12-wheelers and the train weighs 300 tons or thereabouts. The new coaches are more comfortable, but they do not hold so many in proportion to their weight, and every increase of weight means fewer persons in each coach. The old 6-wheeler weighed 15 tons and held 50 people, that is 3·3 persons

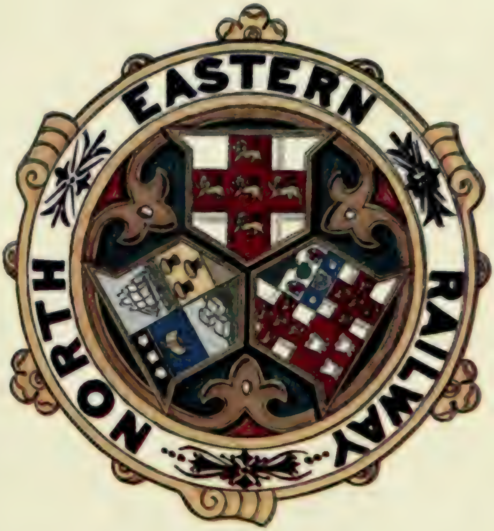
The Dining-room of the King's Car.

for each ton; the 8-wheeler weighs 24 tons and it holds 70 people, that is 2·9 passengers per ton; the 12-wheeler weighs 36 tons or more and holds 72 people, that is 2 passengers or less per ton. Adding their luggage, which is generally up to the limit that goes free, you will find that every passenger means double as much to haul as in the palmy days of railway dividends.

As with the passengers so with the goods. In the old days of leisurely delivery the orders were large in order that a stock might be kept by the dealers. Nowadays the railways have so improved their services that goods collected at night are delivered next morning with almost the certainty of letters. The result is that whereas the dealer used to order in tons he is now contented with hundredweights, and the packages that have to be handled and booked are twenty times as many. The men behind the scenes in railway work have to be more numerous every year; and the net profit suffers. It is the penalty of efficiency.

An East Coast "Flier."

THE NORTH EASTERN



COAT-OF-ARMS

York Station.

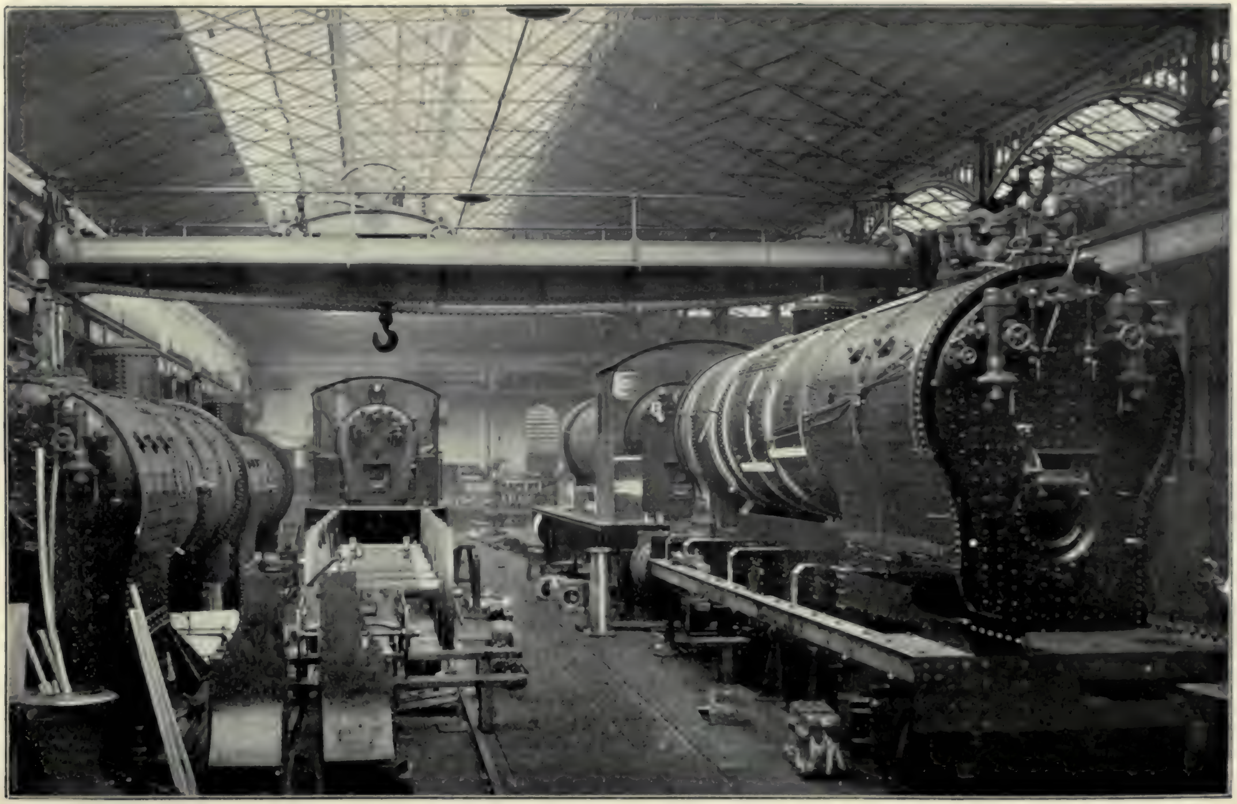
THE NORTH EASTERN

The North Eastern became first known under that name in 1854. It is an amalgamation of all the railroads that previously existed in the North Country, and as one of those roads ran past the cottage at Wylam before George Stephenson was born there, it is clear that the pedigree of the North Eastern goes further back than that of the Stockton & Darlington. We have, however, in the introductory chapter said all we have room to say about those early lines, and will here take up the story where the introduction left off.

As the Great Western was due to the difficulty of navigating the Thames, so the Stockton & Darlington owed its origin to the difficulty of navigating the Tees, ships taking as long to sail from the river-mouth to Stockton as they did from the Tees to the Thames. So embarrassing was the navigation that in 1768 Brindley and Whitworth had been engaged in a survey, according to Smiles, for a canal, and according to Pease for a tramline, for which the subscription list failed to fill. That seems to have been the first survey.

In 1810 the Tees Navigation Company saved a couple of miles of the river journey by making the New Cut of 220 yards, but this was a trifle compared with the growth of the traffic, and it was evident that something else would have to be done. Meanwhile Edward Pease, of the woollen mills at Darlington—" Neddie Pease who started the Stockton & Darlington when he was already fifty years old," and lived till he was over ninety-one—had become satisfied that the old plan of a railroad was " as good as a canal and cheaper," and, owing to him, John Rennie was called in to survey and advise, whose report appeared in 1815 and resulted, after three years' consideration, in two parties becoming prominent in 1818, Stockton being anxious for a canal and Darlington being in favour of a railroad.

Then Jonathan Backhouse, the Darlington banker, endeavoured to bring about peace between the rival factions by suggesting that the Tees should be made navigable up to Yarm, and that the railroad should run from Yarm to Darlington and on to the collieries, and in this proposal he was joined by Thomas Meynell, the squire of Yarm. Stockton would have none of this, and so the project was put to the vote at Darlington, when the majority was in favour of Pease's plan of a line all the way. Having failed in their efforts at conciliation, both Meynell and Backhouse joined with Pease. Residing in the neighbourhood was Thomas Richardson, Pease's cousin, a retired bill-broker whose financial abilities were of the best ; he joined the triumvirate, and it was really these four men who brought about the Stockton & Darlington.



THE MAKING OF A MODERN LOCOMOTIVE

Rennie's survey met with the fate of so many surveys by his sons. The Bill was introduced into Parliament in 1818 and failed to pass ; he had taken his line too near one of the Duke of Cleveland's fox-coverts. George Overton of Llanthetty near Brecon, the engineer of several of the South Wales lines then successfully working, was called upon to make a third survey, and on the 20th of October 1818 had submitted his plans, and, on an inquiry as to cost, offered to make the railway for £2000 a mile, single track, £2400 a mile "formed for a double road," and £2800 a mile if laid with a double track.

These terms were not accepted, and on the 19th of December 1818 Robert Louis Stevenson's father, Robert Stevenson of Edinburgh, the lighthouse engineer, the man who built the Bell Rock and Skerryvore, was asked to make a fourth survey, which did not suit. The decision was conveyed to him in an amicable way ; in fact all this business was done as pleasantly and quietly as possible, for remember this was the Quakers' Line, nearly every shareholder being a member of that community to whom our railways are mainly due, and Stevenson continued to be consulted up to July 1821, when he was succeeded by George Stephenson.

It is not every one who has been to Yarm, but those who may find themselves in North Yorkshire might do worse than call in at the George and Dragon there, when they will find within a marble tablet that may surprise them. There, as the tablet records, on the 12th of February 1820 took place a meeting of the promoters of the Stockton & Darlington Railway, Thomas Meynell of Yarm in the chair, at which it was decided to introduce into Parliament during the session of the following year the second Bill. In preparation for that Bill, Overton made another survey, the fifth ; and on the 19th of April 1821 the Act was obtained. The first rail was laid by Meynell with great ceremony near St. John's Well, Stockton, on the 23rd of

May 1822. He was an excellent man for the work ; pity it is that others have not been like him ! Soon after the ceremony a boy with papers in his hand was shouting in Stockton streets, " Speech of Mr. T. Meynell. One penny ! " A man bought one and found nothing but a sheet of blank paper. " Why, you little rascal, there's nought here ! " " No, sir," replied the boy, " because he said nought ! "

Shortly after the securing of the Act, Edward Pease was writing in his room when a servant announced that two strange men wished to speak to him. He was busy, and he sent them a message that he was too much occupied to see them. Hardly had he done so than he thought that perhaps he had been unkind, and he rose from his chair and went downstairs. Asking where the men were, he was told they were in the kitchen. Going into the kitchen he found them, and they gave their names as Nicholas Wood, viewer at Killingworth Colliery, and George Stephenson, engine-wright at the pits.

Pease sat down on the edge of the kitchen table to listen to what they had to say, and Stephenson handed him a letter from Mr. Lambert, the manager of Killingworth, recommending him to the notice of Pease as a man who understood the laying down of railways. Pease read the letter and took stock of " Old George." As he said afterwards, " There was such an honest, sensible look about George Stephenson, and he seemed so modest and unpretentious, and he spoke in the strong Northumberland dialect "—and, in short, he took to him at once. Here was a man after his own heart.

In the conversation that followed Stephenson agreed that Pease had done wisely in proposing an edge railroad notwithstanding that, though any one might use it, as on the old Surrey line, the only traffic it could take must go on flanged wheels ; but he asked for information as to what was meant by the vehicles being drawn " by men, horses, or otherwise "—a phrase that had been adopted from the

Act of the Oystermouth Railway at the suggestion of Overton, who knew what steam was doing in South Wales and the Forest of Dean—and he learnt that all the calculations had been made on the basis of horse-traction, though steam might be used later on. It was that " or otherwise " that had brought him to Darlington, and he thereupon told Pease that he would do much better in using locomotives to start with. " Come over to Killingworth and see what my Blucher can do ; seeing is believing, sir."

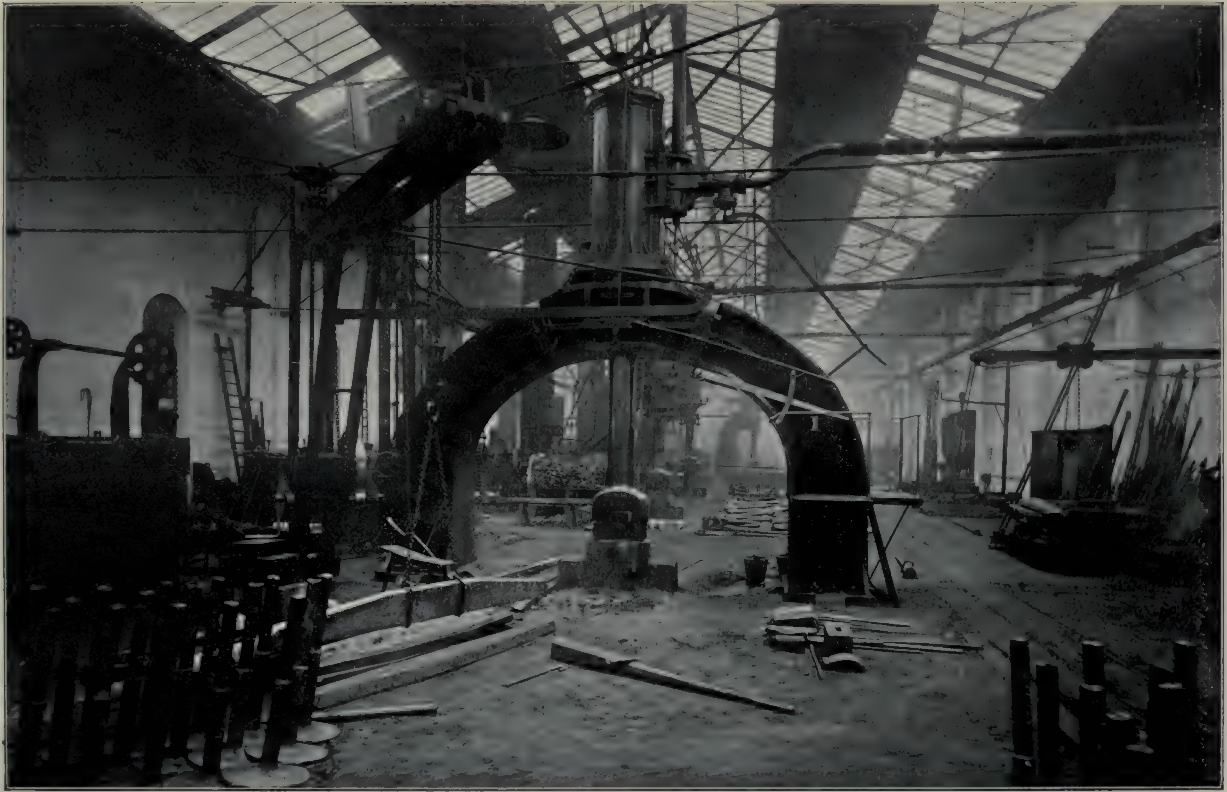
A Powerful Type—Goods Engine No. 2116 (0-8-0).

The interview ended in Pease promising to support Stephenson's application for the appointment of engineer, and agreeing to visit Killingworth and see what was going on. Stephenson was appointed, the edge rail was adopted instead of the flat rail, and Stephenson was desired to make a resurvey of the proposed route as soon as possible. This, the sixth and last survey, was at once begun by George Stephenson and John Dixon, assisted by Robert Stephenson as chainman ; and in the summer of 1822 Edward Pease and his cousin Richardson went over to Killingworth to see and believe. Further, in 1823 the company obtained an amending Act giving them power definitely to use locomotives and to haul and carry passengers as well as merchandise.

The line was made as resurveyed from Witton, through Darlington to Stockton. There were stationary engines at Brusselton and Etherley; and it was from the "Permanent Steam Engine below Brusselton Tower" that the proprietors and their friends, "after examining the extensive inclined planes there," started on the opening day, the 27th of September 1825. First came a man with a red flag, then "The Company's Locomotive Engine" (Locomotion, No. 1, now the monument at Darlington, known by the ignorant, like that at Newcastle, as Puffing Billy, which it is not, Puffing Billy being at South Kensington), then "The Engine's Tender" (described as a water-barrel on the top of a muck wagon), then six wagons laden with coals and merchandise, then "The Committee and other Proprietors in The Coach belonging to The Company" (that is the Experiment), then came six wagons for strangers, and, according to the printed programme, forty-four other wagons, though there were not so many. It was a great triumph, but the man to whom it was due was not there.

That day Edward Pease's son Isaac died, and in the silent room he heard the distant cheers telling him how his work had received its completion in the hour of his bereavement. That he was one of the best and greatest, "a man who could see a hundred years ahead," has long been acknowledged, and by the publication of his diaries it has been amply confirmed. Unusually able, thoroughly genuine, and ever thoughtful for others, it is only natural that his native town should be proud of him, though in his lifetime he told the townsfolk plainly that he was not the father of railways, and absolutely refused to mount the high pedestal on which they would place him. To quote his own words, "Does it not do me some injustice in rendering me more than justice?"

The line was single, with a loop at every quarter of a

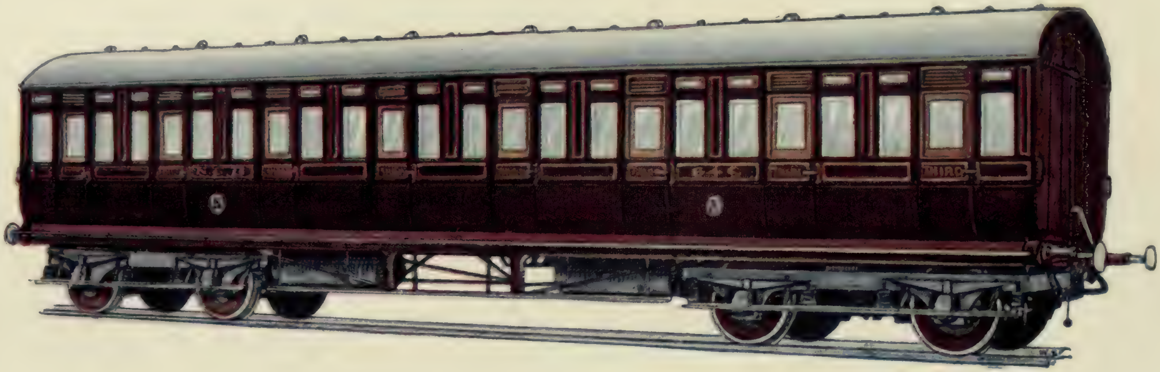


THE FORGE AT THE GATESHEAD WORKS—THE NASMYTH HAMMER mile; with its four branches it was 36¼ miles long, and it cost £9000 a mile, that is about four times as much as George Overton had offered to make it for. When consulted as to the rails, Stephenson told the directors that though it would put £5000 into his pocket to supply the cast-iron rails, the patent for which was the joint property of himself and Losh, yet he could not recommend them—"They will not stand the weight, and you will be at no end of expense for repairs and relays"—and he advised them to use Birkinshaw's patent. So the rails—only half of them, according to some accounts—were of malleable iron, fish-bellied in pattern, 28 lb. to the yard, 2¼ in. broad at the top, 2 in. deep at the ends, 3¼ in. in the middle, with a flange of ¾ in. Some of them were laid on stone blocks and some on oak sleepers well bedded in the ballast.

The Experiment was the first passenger carriage of the Stockton & Darlington, but it was not the first railway coach, for, to say nothing of Trevithick's, one had been running for years on what is now part of the Glasgow & South Western. Indeed, the idea of railway carriages had already become so developed that, the very year the Stockton & Darlington opened, William Chapman, the engineer, at the meeting of the London & Northern Railway, had spoken of "conveying passengers with speed and convenience from place to place, which may be done in long carriages resting on eight wheels and containing the means of providing the passengers with breakfast, dinner, etc., whilst the carriages are moving"—which is worth remembrance as being the first mention of restaurant cars, and 8-wheelers, that has yet been lighted upon.

For some time after the opening day the Experiment was not drawn by an engine but by a horse. It was built by Stephenson at Newcastle from his own design, and was like a builder's movable office on four wheels. There were three windows on each side, and the door was at the end; along each side ran a row of seats, and in the centre was a deal table on which a candle was placed to lighten the darkness. This Experiment is shown as forming part of the train in the pictures of the opening trip; but, according to the model and handbill at South Kensington, there was put on the line on the 10th of October another Experiment. This was an ordinary coach-body fixed on two longitudinal beams 12 ft. in length. It was 5 ft. 3 in. wide and stood 7 ft. from the rails, and the two pairs of flanged 34-in. wheels were on axles in bearings without springs. It carried six inside and about twenty outside, one of whom was the guard, who by means of an iron rod applied the brake, there being two brakes, one to each right-hand wheel. Here for the first time was the railway guard seated on the top of the carriage, and though it is clear that it was not the first passenger vehicle used on this railway it may have been the first with a coach-body, and thus set the fashion for railway coaches for many years.

In August 1823 the first piece of land was bought in Newcastle for the Forth Street Works, destined to be known all over the world. Stephenson, recognising that the workmanship of his engines might be improved upon, had resolved on having a factory of his own, and talking over the matter with Edward Pease offered to invest the £1000 he had received as a testimonial from the coalowners for his invention of the safety-lamp if another £1000 could be found, and Pease and Richardson had joined him in partnership. On the 13th of December 1824 Michael Longridge, then manager, was instructed to buy some adjoining land for a foundry in which the firm could cast its own cylinders, and on the 30th of December to open an office for engineering and railway surveying. This was the first extension, and the partners then were George Stephenson 2 shares, Robert Stephenson 2 shares, Edward Pease 2 shares, Thomas Richardson 2 shares, Michael Longridge 2 shares, making 10 altogether. The first two engines had been built, they were those for the Hetton



THE NORTH EASTERN RAILWAY

THIRD-CLASS CARRIAGE, NO. 646

Extreme length . . 49′ 0″ Extreme width . . 8′ 10″ Extreme height from rail . . 12′ 11″
Seating accommodation . . 80 Carried on two 4-wheel bogies.
Electric lighting. Vacuum brakes.

Colliery, and early in 1825 the building of the third engine was begun, this being No. 1 of the Stockton & Darlington, named Locomotion.

This engine had two vertical cylinders, placed fairly deep in the boiler, 10 in. by 24 in., which drove the 4-ft. driving wheels by side connecting rods. She was a 0–4–0 with the cast-iron wheels coupled by external rods keeping the driving crank-pins of the front and rear wheels at right angles. The valves were driven by rocking shafts, receiving their motion from a single excentric on the leading axle, one of the shafts working direct and the other through a bell-crank. The valve rods were disengaged and reversed by the driver mounting a platform that ran along each side of the boiler. The exhaust steam from both cylinders was led by two blast-pipes, one from each, into the chimney, with the result that the chimney got red hot; and the water was forced into the boiler by a 4-in. feed-pump driven by a lever from the front crosshead. The boiler was 4 ft. by 10 ft., and the single flue was 2 ft. in diameter delivering into the 17½ in. chimney, the heating surface being about 60 sq. ft. The tender that eventually took the place of the wagon and water-barrel held 15 cwt. of coals and an iron tank with 240 gallons of water. The engine weighed 6½ tons and was about 20 horse-power. There is a model of her at South Kensington appropriately placed on a model of George Stephenson's first bridge, that at West Auckland, which was replaced by the present one in 1901.

The fourth, fifth, and sixth engines built at Forth Street were Nos. 2, 3, and 4 of the Stockton & Darlington, known as the Hope, the Black Diamond, and the Diligence. No. 5 was the Stockton, built by Wilson of Newcastle in 1826. Wilson was so deeply impressed with what he called the dangers of coupling-rods that he would have none of them, and he fitted his engine with four vertical cylinders, 6 in. by 18 in., a pair of cylinders to each pair of wheels.

In a way it was the first 4-cylindered engine, and though it had a boiler 4 ft. 4 in. by 13 ft. its tractive factor was only 27, and failure was inevitable. So the Stockton was broken up and parts of it were used in the new No. 5, the Royal George, built at Shildon engine-shed in 1827 by Timothy Hackworth.

Hackworth, like Stephenson, was a native of Wylam, having been born there on the 22nd of December 1786. He was a smith, we may say, from the commencement, quite a Wayland Smith who could do anything with metal. He had a hand in building Puffing Billy, and for twenty-five years was behind the scenes in all this engine-building, watching, thinking, contriving, never at a loss for a happy thought ; but what he definitely did until he became the first locomotive superintendent of the Stockton & Darlington and got credit for his own work, and perhaps in the same way for other people's, is a mystery, for he was anticipated in everything that is ascribed to him by other men's detractors. All that could be said against him was that he was a Methodist, and that was said by the people who dismissed Pease as a Quaker, Hudson as a draper, and Thompson as a man who kept a drug-shop ; but if we are to inquire into the religion and antecedents of all our railwaymen, including the directors, even in our own day, what surprises there would be, and what instances we should have of men who have left the trade in which they had to start for one more suited to their abilities ! Timothy, that is Hackworth, was the first foreman of the Forth Street Works, and on the 13th of May 1825 he was appointed, on Stephenson's recommendation, " superintendent of the permanent and locomotive engines " of the new line, just as John Dixon was appointed its permanent way engineer.

At the same time as Wilson delivered the Stockton, Stephensons delivered the Experiment, No. 6 of the railway list. This was the first 6-coupled engine, and Hackworth adopted six wheels of the same diameter, 4 ft. for the Royal George, which was completed a year afterwards; but he drove from the hind wheels instead of the front ones, and placed his cylinders vertical instead of at an angle of 45. The Experiment had two tubes 18 in. in diameter, and there were two blast-pipes as in the Locomotion and her sisters; Hackworth, using the Stockton's boiler, increased the heating surface by adopting Trevithick's return flue, and, by running the pipes from the two cylinders into one before entering the chimney, he also reverted to Trevithick's central steam-blast. Like him he used the exhaust for heating the feed-water, but in a different way, the exhaust being turned into a water-cistern, the feed being supplied by short-stroke force pumps worked by excentrics; and, what was also new, he used some of the exhaust as a jet under the fire-grate. The cylinders were 11 in. by 20 in., and the piston rods were guided by parallel motions

No. 695, a heavy Tank Engine for Local Traffic.

the levers of which worked the valve shaft. The driving wheels were without springs, but the load on the other wheels was carried by long plate springs arranged as equalising levers. The working pressure was 50 lb., and this was so well utilised that the engine could draw on the level 32 wagons weighing 130 tons at a speed of five miles an hour.

No. 7 was Stephensons' first Rocket, not unlike the Experiment; then followed No. 8, Hackworth's Victory, built in 1829 at Shildon, no longer engine-shed but railway works. Next year Hackworth designed, and Stephensons built, No 9, a queer-looking locomotive of a character of its own called the Globe from the copper sphere in which dry steam was collected, the predecessor of the steam dome. Quaint as the Globe looked with her handrail round her, she did very well until she blew up in 1839. Then came the Majestic class of six with vertical cylinders overhanging in front, and then the Wilberforce class of six, also 6-wheelers coupled, with cylinders overhanging behind and two tenders, one in front of the engine with coals and the stoker, for they were stoked in front under the chimney, and the other behind, the driver being in the rear tender which carried the water in a gigantic cask—strange things, all the stranger at night when they carried cressets of burning coal instead of lamps. Later came Kitching's Derwent, which stands tender to tender with the Locomotion at Bank Top between the two main platforms. Then matters began to settle down, and gradually the engines took on their familiar shape, and Timothy Hackworth's last, the second Sanspareil of 1849, was as good in looks as any on the rail, and powerful and speedy, for she was driven at times at 80 miles an hour.

The Stockton & Darlington soon began to thrive, some of its prosperity being due to the clause in the Act inserted at the instigation of George Lambton, afterwards the second Earl of Durham. This clause, limiting the rate for all coals carried to Stockton for shipment to a halfpenny a ton per mile while fourpence a ton was allowed for all other coals, was to protect his own coal trade from Sunderland and the northern ports, it being so low he thought as to render all competition hopeless.

Edward Pease had calculated on sending 10,000 tons a year to Stockton, and to his surprise—and to the greater surprise of Mr. Lambton—the amount taken thither and to Middlesbrough, which had started under the name of Port Darlington lower down the river, soon reached half a million tons, the halfpenny rate proving highly profitable. The traders applied for a reduction, it is needless to say where the suggestion came from, but were met with the reply that, much as they regretted it, the directors could not alter the Act of Parliament; and so the railway prospered and Stockton and Middlesbrough prospered. Then the Liverpool & Manchester proved another success in all ways, and, among other places, York began to ask why it

Third-class Corridor Carriage No. 24. East Coast Service.

should not also help a railway company to put it into communication with the rest of the world.

A committee of the corporation was appointed in 1832 to consider the matter, and one of the members of that committee was George Hudson, who set to work to learn all he could about railways and how to manage them. It was not railways that put him on the corporation, but the corporation that put him on railways. He would have been Lord Mayor of York if railways had never existed ; no man ever had a more honourable introduction to the mysteries of railway finance. In 1827 he had been left by a relative a legacy of £30,000 ; in 1833 he had founded the York Banking Company, of which he was the first manager, and that year he had become the head of the Conservative party in York. Whatever he did he was throughout thoroughly devoted to his native city, and in defending the two great systems with which he was chiefly associated, the Midland and the North Eastern, he did what he thought best for its interests as well as his own.

Nearly three years elapsed without any decision being come to by the corporation committee, and then, in the summer of 1835, Hudson went for a holiday to Whitby, where he met George Stephenson and heard the latest railway news at first hand, particularly as regards the projects which affected York. On his return he reported to his committee what had passed, and acting on his advice they withdrew from their intended support of a direct line to London and contented themselves with helping in the promotion of the much less risky short line from York to Normanton to join the North Midland.

This was the York & North Midland, and in it Hudson invested the whole of the £30,000 that had come to him as a windfall. At the same time the committee decided to support the Great North of England, an imposing title which merely meant a line from York to Newcastle, or rather to Redheugh on the south bank of the Tyne, which passed through Darlington. Both these lines were wanted, both were authorised, and both were surveyed and engineered by the Stephensons. The York & North Midland was opened in 1840. The York to Darlington section of the Great North was opened in 1841; the Newcastle to Darlington, built by a separate company, in 1844.

First-class Corridor Brake No. 3754.

The amalgamation of these two made the York & Newcastle, and when this joined the Newcastle & Berwick, the company became the York, Newcastle & Berwick, which in 1854 absorbed the York & North Midland, the Leeds Northern, and the Malton & Driffield to form the North Eastern. What the history of these companies had been up to then may be gathered from the speech of the chairman, Mr. James Pulleine, at the first meeting of the North Eastern on the 29th of August 1854, when he congratulated the shareholders on assembling "as one body instead of being engaged in unfortunate disputes, competition, and minor jealousies by which particular classes of traffic were guided to particular districts, instead of being carried in a way which would be of service to the whole."

The York & North Midland was an easy line to make, the engineering features being in no way noteworthy, and the York to Redheugh—up to Ferryhill at 1 in 600, with a few short descents, then seven miles of a sharper rise, then five miles at 1 in 150, and downhill at the same slope for eight miles and easy to the Tyne—was not much more difficult; but the Newcastle & Berwick, beginning with a bridge and ending with a bridge, was quite a different task. To begin with, there was a competing scheme. In 1836 George Stephenson had surveyed two routes, one of which, that by the coast, had been adopted after an interval of nine years; but another company had employed Brunel to survey for a broad-gauge line, and, what was worse, an atmospheric broad-gauge line, and he, beset with the notion that to the atmospheric gradients did not matter, had planned a grand route that rose and fell like a switchback.

It was the South Devon over again, only more so. Proposed for locomotives it would have been laughed out of the committee room, but for the atmospheric it was a different matter, and never was there a scheme that afforded a finer field for a conflict of opinion, especially when a prime minister, Sir Robert Peel, led the atmospherics and made the matter almost a party question. Fortunately the Conservatives, with Hudson prominent in the background, for he was to enter Parliament a few weeks afterwards, formed a cave, and on the 31st of July 1845 the Bill passed and Brunel's people were saved from losing their money; and so delighted were the Newcastle men at the defeat of the broad-gaugers that they took a holiday and marched about the town with flags flying and bands playing.

The engineer was Robert Stephenson, and the works were soon put in hand. To begin with there was the Tyne to be bridged by the famous High Level. The Newcastle corporation had insisted on the bridge carrying a road as well as a railway, and this was easily and ingeniously arranged by putting the railroad on top. Every one knows the bridge with the railroad on the bows and the high road on the strings. When it was begun there had been more than 25,000 railway bridges built in this country during the preceding fifteen years, and there was plenty of experience.

First-class Dining Saloon.

Down in the bed of the river went the piles under the fearful punching of Nasmyth's new steam pile-driving machine, a modification of his famous hammer, at the rate of eight feet a minute, two hammers of a ton and a half each striking every second and oftener, going so fast that "on many occasions the pile-head burst into flames during the process of driving." No sooner was one down than the hammer head travelled along to another, and into the solid bed of the river the huge balk of timber was thrust almost as easily as a pin into a cushion, bang, bang, bang! the waste steam flashing out at the end of each stroke as if it were the smoke from a gun.

The Queen's Car—the Drawing-Room.

Then the coffer-dams were formed and puddled, and the water was pumped out to leave the river-bed bare. The middle pier, as usual, was the difficulty, for here the piles had gone through a quicksand through which the water forced itself as fast as the pumps lifted it out. The pumping went on for months, and the water still kept its level.

Round the piling chalk was tipped, but to no purpose, and there had to be a limit to that treatment or else the river would have been blocked. Then hydraulic concrete was shot into the coffer-dam and the difficulty mastered. Up to the level of the pier-heads the concrete was taken, and then the freestone went on from about two feet below low water; and with 400,000 cubic ft. of ashlar, rubble, and concrete in the piers, and 450,000 ft. more in the arches and approaches, the structure was ready for the iron, cast and wrought, in that wonderful combination of the arch and the suspension.

The Queen's Car—the Dining-Room.

Each of the six arches of 125-ft. span consists of four main ribs in pairs, with a distance between the inner arches of 20 ft. 4 in. to form the roadway, the outer arches being 6 ft. 2 in. apart to form the footpath. Each arch is in five separate segments, the ribs springing from the horizontal plates of cast iron bedded on the stone piers, and of each arch one end is fixed and the other free to allow of expansion, thus every arch is independent and the piers have simply to support a vertical pressure. The bridge is 83 ft. above high-water mark on the underside, and, with the viaducts, is 4000 ft. long. The first pile was driven on the 6th of October 1846, and the bridge was opened on the 15th of August 1849, "a monument of the highest engineering skill of our time, with impress of power grandly stamped upon it."

There are three sets of rails on it, and no bridge was more used; indeed the traffic over it increased and increased until 800 trains and light engines were crossing every day, and then it became necessary to build another. In building it Robert Stephenson's assistant was Thomas Elliot Harrison of the Great Western 10-footer Hurricane, and the geared-up-to-18-footer Thunderer, and the inventor of the communication cord that ran along the top of the sides of the coaches; it was his nephew, Mr. Charles A. Harrison, who built the King Edward Bridge, 800 ft. higher up the river, curiously enough at Redheugh. This is a railway bridge only, but it has four sets of rails and is no unworthy sister. The first stone was laid on the 19th of July 1902, and the opening was on the 10th of July 1906.

When Stephenson built the older bridge the Tyne could almost be forded at low water, but now the Tyne Commissioners have dredged and dredged until there is a channel 28 ft. deep and a tide range of 15 ft., so that bridge-building is not so easy as then in that respect. Sixty-nine feet down below high-water mark the central pier extends; in it are 195,000 cubic ft. of granite, mostly Norwegian, and in each of the north and south piers 135,000 ft.; right and left of the centre the lattice girders measure 300 ft. and weigh 3482 tons, the north span weighing 950 tons and the south span 1350 tons.

The bridge is not only noteworthy for itself but for the improvement of which it formed part. Formerly trains crossing the High Level into Newcastle Station had to come out by the way they went in. Now the station has been enlarged so that the East Coast trains can run through it, and coming from the south they cross the new bridge, enter Newcastle Station on the west and leave it by the east on their way to the north.

Newcastle is much the largest station on the North Eastern, though York is often said to be so ; it has 15 platforms, nearly 7 acres of it are under glass, and nearly 850 trains enter it in a day. It has one of the largest signal cabins in the country, there being 259 levers with space to increase to 300, the levers being small owing to their being worked on the electro-pneumatic system.

Another great bridge in which, as in the High Level, the railroad is carried on top of the roadway, is also due to Mr. Harrison. This is the one at Sunderland over the Wear, which has the heaviest span in Britain. In the main bridge are four spans, the river being crossed 85 ft. above high-water mark by one of 300 ft. The girders of this are nearly 354 ft. long and are 42 ft. high in the centre, and weigh 960 tons, the weight of the span being 2600 tons. To avoid interference with the navigation the bridge was built by treating the main girders as cantilevers and extending them, member by member, from the piers until they joined in the middle. In the main bridge there are 8500 tons of steel, and it is approached by nine other bridges, the engineering work being great, and the materials used — granite, freestone, bricks, etc. — running into enormous quantities. This tremendous bridge was completed in June 1909.

At the other end of the Newcastle & Berwick was the Border Bridge built by Robert Stephenson. This is a noble viaduct of 28 arches. The old picturesque bridge, 17 ft. wide, built in the early Stuart days—it was begun in 1609—has 15 arches, and took 24 years and 4 months to complete; Stephenson crossed the river at a much higher level, and built his bridge in 3 years and 4 months. Each of the semicircular arches is of 61½ ft. span, the greatest height above the Tweed being 126 ft., the length of the whole being 720 yards. Here again Nasmyth drove the piles, each of which can sustain a load of 70 tons. In the river-work bricks were used set in cement, and on them and elsewhere came the ashlar with a hearting of rubble.

Its name is the Royal Border Bridge, from its having been opened by Queen Victoria in 1850, but it does not cross the Border. Berwick, though on the north side of the Tweed, is in England, not Scotland. It is the extreme north-east point of Northumberland. The station is on the site of the old castle; there the North Eastern ends and the North British begins.

In 1839 there had been opened the Newcastle & North Shields, from Pilgrim Street to that smoky seaport, and the same year there was opened throughout the Newcastle & Carlisle, the Act for which had been obtained in 1829. This went by Hexham and Haltwhistle to the canal basin at Carlisle, where the goods were transhipped to and from the vessels trading with the Solway. Westward it went through Wylam and the Stephenson country. At Blaydon it joined the Blaydon, Gateshead, & Hebburn, which it bought, and at Redheugh was the Brandling Junction, opened in September 1839, which went through Gateshead to South Shields and Monkwearmouth.

The Newcastle & Carlisle—absorbed by the North Eastern in 1862—was partly opened in May 1835. It was noteworthy for being worked on the wrong side, the trains passing one another to the right hand, as on the Dundee & Arbroath and the Greenwich line, instead of to the left. On it the first engine was the Comet, a 0-4-0 built by the Hawthorns in 1835, the cylinders of which, 12 in. by 16 in., were hung under the smokebox, the piston-rods passing beneath the leading axle of the 4-ft. coupled wheels to work on the rear axle. Another curious engine of this line was the Tyne, also built by the Hawthorns, to which, taking the place of a whistle, was attached Birket's steam-organ of eight pipes, on which the driver, instead of giving a shriek, played a pleasing tune when danger was nigh.

The fastest Train in Britain—Darlington to York.

But in the beginning there was more danger behind the engine than in front of it, for our old friend Nicholas Wood, the engineer of the line, tried to run round the curves more easily by having one wheel of each pair fitted loose on the axle to allow of its moving inwards or outwards. To quote his own words, " the axle was turned very accurately and then there was a groove cut in the axle, the nave of the wheel was bored to fit the axle and a groove cut in it, and then a piece of steel interposed between the groove of the axle and the wheel, so that the wheel could move in and out and not turn round the axle "—and the carriages thus fitted ran off the track so frequently that a trip to Carlisle was as exciting as a steeplechase.

The Newcastle & North Shields and its extensions, in fact all the branches east of Newcastle, are now electrified, and the North Eastern and Lancashire & Yorkshire are running fairly level as by far the longest electric lines we have, sixty miles and more of each of their tracks being so arranged as to be workable either by steam or electricity. The North Eastern has about 60 electric motors and 2000 steam locomotives to run their 30 millions of miles a year on its 1700 miles of road, hauling 60 million passengers, 50 million tons of minerals, and 15 million tons of merchandise in its 113,000 wagons and coaches. In the beginning it looked for its chief profit to minerals and merchandise, and it has had it so all through its career. The character of its main source of income was not without its influence on its early engines, when engine-work was not so specialised as now, and that influence still remains.

Gateshead, the locomotive headquarters for so long, will soon be used only for repairs. When York locomotive works were closed those at Darlington were enlarged, and they are to be further enlarged that all the engines may be built there. The Stockton & Darlington, which then had some twenty branches, was absorbed by the North Eastern in 1863, and the old works at Shildon are now used as wagon shops in addition to the carriage and wagon works at Heaton and York.

The engines of the separate companies, excepting the Stockton & Darlington, were of the stock patterns of private firms, but after the amalgamation, when the North Eastern began in name, a few distinctive details appeared,

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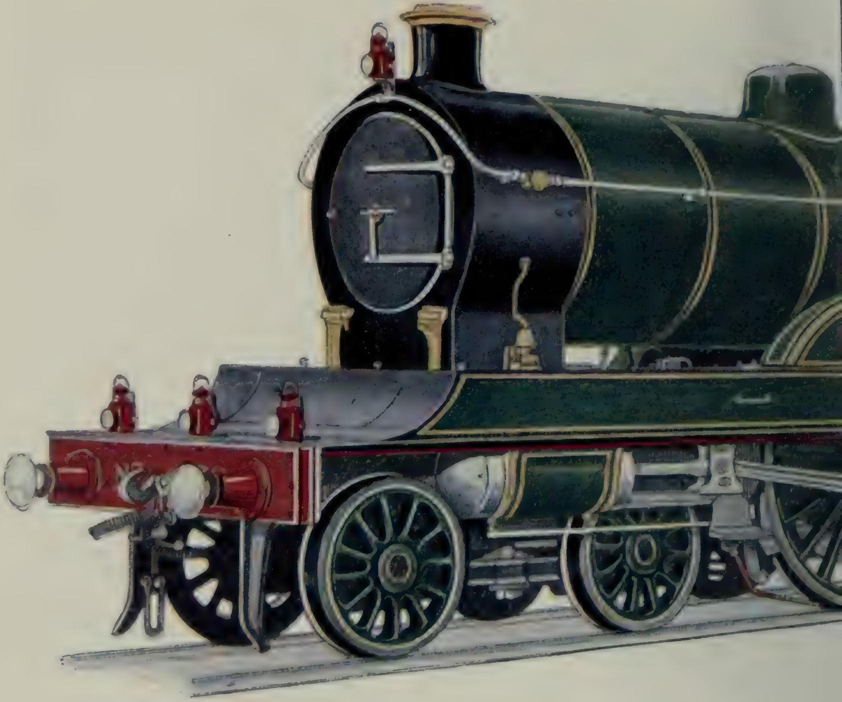


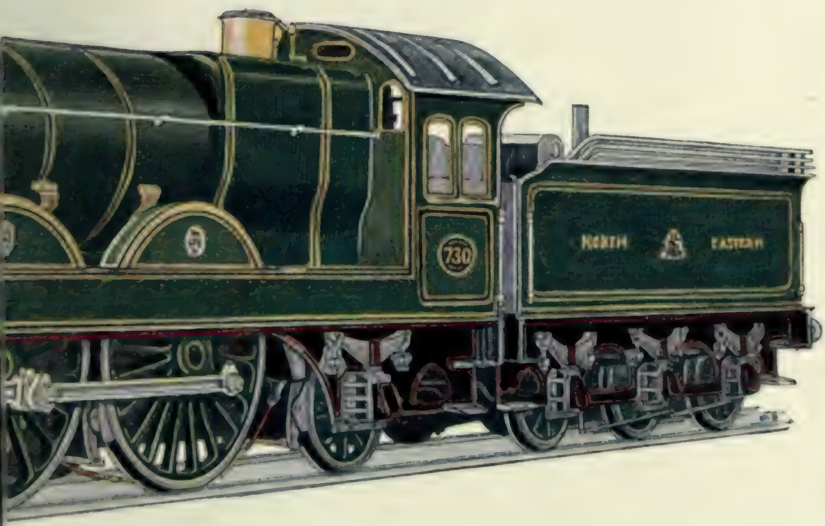
THE NORTH EA

EXPRESS PASSENGER

DESIGNED BY MR. WILS

BOILER	Length		15′ 0″
	Diameter		5′ 0″
CYLINDERS	Diameter	Two H.P.	1′ 2¼″
		,, L.P.	1′ 10″
	Stroke		2′ 2″
TUBES	No.		227

FIRE BOX	Length	9′ 0″
	Width	4′ 1″
HEATING SURFACE	Tubes	1782 sq. ft.
	Fire box	180 ,,



TERN RAILWAY

OCOMOTIVE, No. 730

ORSDELL, M.INST.C.E.

DIAMETER OF WHEELS	Bogie	3′ 7¼″
	Coupled	7′ 1¼″
	Trailing	4′ 0″

GRATE AREA . . . . . 29 sq. ft.

WORKING PRESSURE 225 lb. per sq. inch.

		Tons.	Cwt.
WEIGHT IN WORKING ORDER	Engine .	73	12
	Tender .	42	12
	Total . Tons	116	4

WATER CAPACITY . . 3800 galls.

COAL CAPACITY . . . . 5 tons.

though not many of them. The East Coast service, as we now know it, dates from 1870 when the extension from York through Selby joined the Great Northern at Shaftholme, instead of the route being by way of Askern, and it has always been that on which the best engines have been used. Here again, however, there is a qualification, for the Great Northern, under running powers, brings the trains to York, so that the North Eastern work is done from York northwards.

The North Eastern and Lancashire & Yorkshire Expresses, Newcastle-Liverpool, passing each other at full speed.

When the route was opened the engines were the Fletchers, with cylinders 17 in. by 24 in. and 4-coupled wheels 7 ft. in diameter. Some years afterwards twenty new express engines were put on the line by Mr. Tennant, these being, like the others, 2–4–0's with coupled 7-ft. wheels, but the cylinders were 18 in. by 24 in., and the heating surface was 1250 sq. ft. They were really good engines, and were easily distinguishable by the cab which looked as though it came from Doncaster.

Mr. T. W. Worsdell began his tenure of office by building No. 1329. This was a single, 4–2–2, with 7 ft. 1 in. wheels, and it was a compound on the Worsdell and Van Borries' principle in which there are two cylinders, the low-pressure to the right, the high-pressure to the left, with the valve chests in the smokebox above the cylinders, the high-pressure exhaust being carried round the box to the low-pressure. In 1886 he followed this with the class that did the work during the race to Edinburgh. These were 4–4–0's with 6 ft. 8¼ in. drivers, the high-pressure cylinder being 18 in. and the low-pressure 26 in., the common stroke being 24 in. Of these engines the heating surface was 1323·3 of which 1211·3 was obtained from the 242 tubes of 1¾ in. outside diameter and 10 ft. long, the grate area being 17·33, the working pressure 175; and they weighed with the tender 81 tons 7 cwt. One of these ran from York to Newcastle in 82 minutes, and from Newcastle to Edinburgh in 128 minutes.

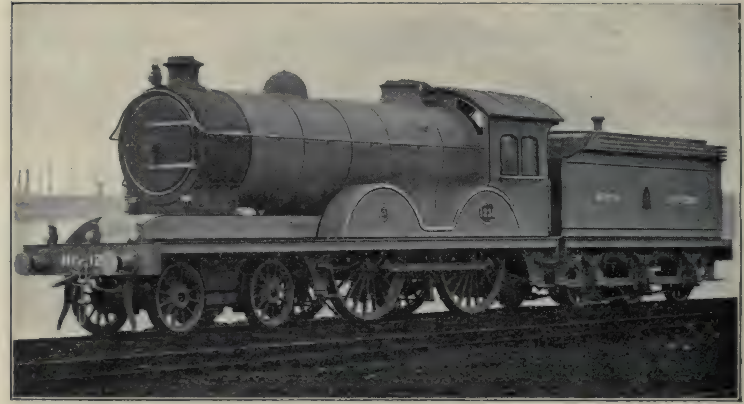
A 25-ton Covered Goods Wagon.

The larger group of 4–2–2's had driving wheels 7 ft. 7¼ in., and the cylinders, 28 in. and 20 in., were so large that, instead of being side by side, they were placed diagonally. The grate area was 20·7 sq. ft., the heating surface 1139 sq. ft., and the pressure 200. In working order the engine weighed 46 tons 13½ cwt., while the tender with its 4 tons of coal and 3940 gallons of water weighed 40 tons 1 cwt. Like the other engines by the same designer, they were fitted with the well-known North Eastern roomy cab which has an American look about it. It was on this line that the cab originated. It began with the wooden board cut out to fit the curve of the boiler which the drivers up Newcastle way used to mount on their engines when the wind was bleaker than usual. From this came the weather-board, then the holes in it to be filled with glass, then the sloping of the upper edge over the driver's head, and then the extension of the sides. Considering what the

An Important Goods Station, Hull.

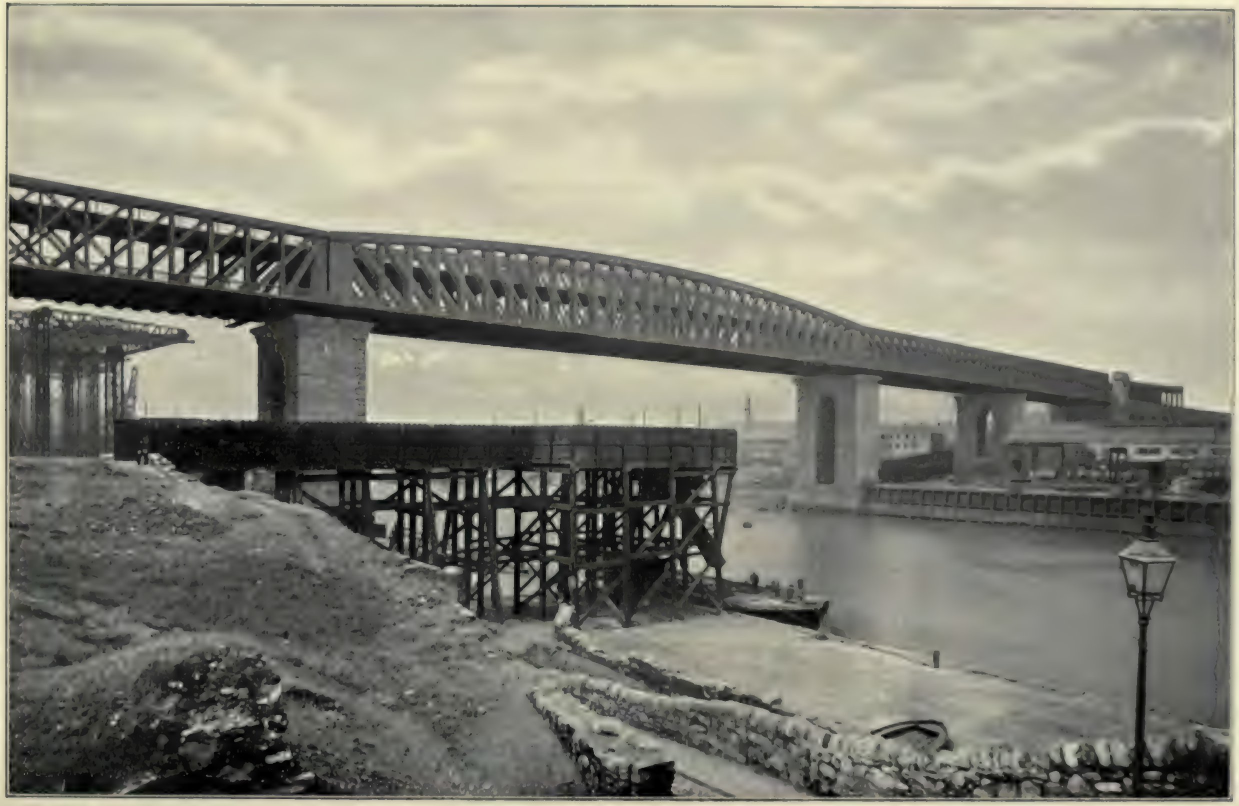
north-easterly wind is like on the road from Newcastle to Edinburgh the cab was a necessity, and we can only wonder that sensible protection for the men on the foot-plate was not available until the days of Mr. Worsdell.

In 1890, after putting some 250 of his compounds on the rail, he was succeeded by Mr. Wilson Worsdell, who in time began to build compounds on the Smith system as already described. He it was who introduced that powerful type the 10-wheeler, 4–6–0, the first being No. 2001 in 1899.



Express Passenger Locomotive No. 1238.

This was an advance in size and power, and No. 2111 was larger. She is a simple, of course ; her 6-coupled driving wheels are 6 ft. 8¼ in., her cylinders are 20 in. by 26 in., her boiler is 4 ft. 9 in. by 15 ft., her firebox is 8 ft. by 3 ft. 11 in., grate area 23 sq. ft., heating surface 1768·86 sq. ft. Then came the North Eastern Atlantics, and now we have No. 1238, that powerful 4–4–0 with 6 ft. 10 in. drivers, and cylinders 19 in. by 26 in., and a working pressure of 225 lb., which, like her nine sisters, is travelling easily with 400-ton trains behind her. We cannot choose a better example for the details of a modern locomotive, and here they are :—



THE BRIDGE OVER THE WEAR AT SUNDERLAND

ENGINE

	ft.	in.
Cylinders—		
Diameter	0	19
Stroke	0	26
Diameter of piston valves	0	10
Width of ports	0	1⅜
Distance apart of cylinders, centre to centre	2	0
Distance between centres of valve spindles	1	0½
Lap of valve	0	1¼
Maximum travel of valve	0	$4\frac{5}{32}$
Lead of piston valve. Forward full gear	$\frac{3}{16}$ in. F.P., $\frac{1}{16}$ in. B.P.	
Diameter of piston rod	0	3¾
,, ,, ,, tail end	0	2¾
Length of slide block	1	3
,, ,, connecting-rod between centres	6	8
Wheels and axles—		
Diameter of driving wheels	6	10
,, ,, bogie wheel	3	7½
Thickness of all tyres on tread	0	3
Width of all tyres on tread	0	5½
Distance between centre of bogie and centre of leading wheels	11	0
Centre of bogie wheels	6	6
Centres of driving wheels	9	6
Distance from centre of driving wheels to front of firebox	1	10¾
,, ,, ,, ,, bogie to front buffer beam	6	1
,, ,, ,, ,, trailing wheels to back buffer plate	6	5
Crank axle : Steel—		
Diameter of wheel seat	0	9
,, ,, bearings	0	8
,, at centre	0	7¾
Distance between centres of bearings	3	10½
Length of wheel seat	0	$7\frac{3}{16}$
Lengths of bearings	0	9½
Plain axle : Steel—		
Diameter of wheel seat	0	9
,, ,, bearings	0	8
,, at centre	0	7¾
Distance between centres of bearings	3	10½
Length of wheel seat	0	$7\frac{3}{16}$
,, ,, bearings.	1	0½
Bogie axles : Steel—		
Diameter of wheel seat	0	7½
,, ,, bearings	0	6
,, at centre	0	5¾
Length of wheel seat	0	7½
,, ,, bearings	0	11
Distance between centres of bearings	3	7
Driving—		
Diameter of crank axle pin for inside connecting-rods	0	8½
Length of bearing for inside connecting-rods	0	5
Diameter of crank pin for coupling-rods	0	3½
Length of bearing for coupling-rods	0	$4\frac{1}{16}$
Frames : Steel—		
Distance between frames	4	0
Thickness of frames	0	1
Distance between bogie frames	2	8
Thickness of bogie frames	0	0¾
Boiler : Steel—		
Centre of boiler from rail	8	11
Length of barrel	11	6½
Diameter of boiler, outside	5	6
Thickness of plates	0	0⅝
Tube plate : Copper—		
Thickness of smokebox tube plate	0	1
Pitch of rivets	0	2
Diameter of rivets	0	0⅞

	ft.	in.
Firebox casing : Steel—		
Length outside	9	0
Breadth outside at bottom	3	11
Depth below centre line of boiler at front end	5	3½
,, ,, ,, ,, back end	4	6½
Thickness of front plate	0	0⅝
,, ,, back plate	0	0⅝
,, ,, sides and top plate	0	0⅝
Distance of copper stays apart	0	4
Diameter of copper stays	0	1
Inside firebox : Copper—		
Length at the bottom inside	8	3⅛
Breadth ,, ,, ,,	3	2½
From top of box to inside shell	1	7⅛
Depth of box inside at front	6	4⅜
,, ,, ,, back	5	7⅜
Tubes : Copper—		
Number of tubes		254
,, ,, stay tubes		7
Length of tubes between tube plates	11	3⅛
Diameter outside		2
Thickness	No. 11 and 13 W.G.	

Diameter of variable blast pipe nozzle	from 4¾ in. to 7⅛ in.
Height of chimney from rail	13 ft. 3 in.
Heating surface in tubes	1579 sq. ft.
,, ,, ,, firebox	158 sq. ft.
Total	1737 sq. ft.
Area of fire-grate	27 sq. ft.

Weight of engine in working order—	tons	cwt.
On bogie wheels	17	10
On driving wheels	42	0
Total	59	10

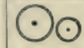
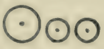
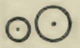
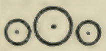
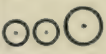
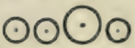
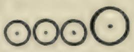
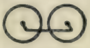
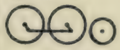
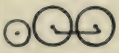
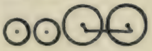
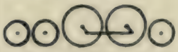
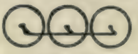
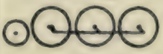
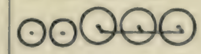
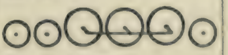
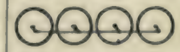
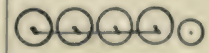
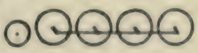
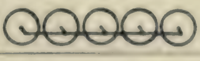
TENDER

	ft.	in.
Wheel base—		
From front buffer beam to centre of leading wheels	4	2
,, centre of leading wheels to centre of middle wheels	6	4
,, ,, ,, middle ,, ,, ,, ,, trailing ,,	6	4
,, ,, ,, trailing ,, ,, back buffer beam	4	5
Wheels—		
Diameter of wheels	3	9¼
Thickness of tyres	0	3
Width of tyres on tread	0	5½
Axles—		
Diameter of bearings	0	5
Length of bearings	0	10$\frac{9}{16}$
Diameter of wheel seats	0	7¼
Length of wheel seats	0	7½
Distance of centres of bearings	6	10
Frames—		
Distance between inside frames	4	1
Thickness of inside frames	0	0½
Distance between outside frames	6	2¾
Thickness of outside frames	0	0⅞

Capacity of tank	3669 gals.
,, ,, well	456 gals.
Total	4125 gals.
Coals	5 tons

Weight of tender in working order—		
On front wheels	13	10
On middle wheels	12	16
On trailing wheels	14	16
Total	41	2

WHEEL PLAN OF BRITISH ENGINES

Formula.	Name or Example.	Wheel Scheme.	Description.
0-2-2	"Rocket"		4-wheel single, front driver
0-2-4	"Earl of Airlie"		single, trailing bogie
2-2-0	"Planet"		4-wheel single, rear driver
2-2-2	"Jenny Lind"		6-wheel single
4-2-0	"Folkestone"		6-wheel, rear driver
4-2-2	Great Western		8-wheel single
4-2-2-0	"Liverpool"		8-wheel rear driver
0-4-0	"Comet"		4-wheel, four-coupled
0-4-2	"Gladstone"		6-wheel, front-coupled
2-4-0	"Precedent"		6-wheel, rear-coupled
4-4-0	"Bessemer"		4-coupled, leading bogie
4-4-2	Atlantic		4-coupled, ten-wheel
0-6-0	Terrier		6-coupled
2-6-0	Mogul		6-coupled, leading pony
4-6-0	"Experiment"		6-coupled, leading bogie
4-6-2	Pacific		6-coupled, twelve-wheel
0-8-0	8-wheel goods		8-coupled
0-8-2	10-wheel goods		8-coupled, trailing pony
2-8-0	Consolidation		8-coupled, leading pony
0-10-0	Decapod		10-coupled

The North Eastern carries more goods and minerals than any of our home railways, and ranks third in length. Northumberland and Durham it has to itself, and most of Yorkshire. Look at its map in which is shown the hill-shading, and notice how its main line runs north and south, fed on the west by tributaries down the river valleys, and drained on the east down the continuation of those valleys to the sea—loop after loop on the coast, and terminal after terminal inland :—

Berwick, Coldstream, Kelso, to reach which it crosses the Border and from which it could be run on Glasgow way if worth while ; Carlisle, tapping Allendale and Alston Moor on the way ; Weardale, and Teesdale up to Middleton reached through Barnard Castle—reminding us of old Ambrose Middleton and his tram, and making us wonder what he would think of things now, when from the castle window, looking on the railway and not on the river, he could, as Walter Scott says, track its wanderings by the steam ; and perchance taking a ticket for Penrith or Tebay he could climb that 725 ft. in less than nine miles on the Westmorland side of Stainmoor and pass over the summit level of the line, 1370 ft., beyond Barras.

Then there is the branch coming in at Eryholme from the Richmond that gave its name to West Sheen on the Thames to make it better known. In the valley of the upper Ure starts the branch from Hawes ; and in the valley of the same river, lower down, that from Masham ; down the Nidd runs the Pateley branch ; down the Wharfe that from Ilkley—each of them serving a district claiming to be more charming than the rest. With Leeds business begins, and we need say no more ; and on the other side detail of any sort is unnecessary, for the whole coast from the Humber to the Tweed is the monopoly of the North Eastern.

York is now recognisable from afar by its water-tower with the 100,000 gallons at the top, and is known to all by the majestic curve of its platforms. On the down main platform there stands the zero post from which, as from a London stone of the old companies that formed its nucleus, the distances are measured. Mysterious initials they are on its labels, but they are clear enough when you know them—Lo. Lp. (Longlands Loop, Northallerton); M.W. & B. (Market Weighton & Beverley); Mic. Br (Micklefield Branch); R.Cv. (Raskelf Curve); S.Br. (Sherburn Branch); Y. & H. (York & Harrogate); Y. & M.W. (York & Market Weighton); Y. & N. (York & Newcastle); Y. & N.M. (York & North Midland); Y. & S. (York & Scarborough): the most notable distance being that of the North Midland, 23 miles 1048 yards, which is a sufficient answer to those who ask why York should have put its money into it instead of into the Direct Northern. Now the system extends from Withernsea on the east to Carlisle on the west, and from Shaftholme northwards to Berwick, Darlington being the centre. And it is from Darlington

No. 1 Erecting Shop at Gateshead—looking West.

to York that the North Eastern runs the fastest train without a stop in these islands, that is the 1.9 p.m. which covers the 44½ miles in 43 minutes, at the rate of 61·7 miles an hour. Our next fastest non-stop running being on the Caledonian, the 6.58 p.m. from Forfar to Perth, 32½ miles in 32 minutes, being 60·9 miles an hour.

The longest non-stop run on the North Eastern is from Newcastle to Edinburgh, 124¼ miles in 138 minutes. This, though one of the oldest, now comes eighth on the list, which may change at any moment when non-stop work is being so much developed. Nevertheless, some such list should be given, and it may as well come here. The longest at the time of writing is the Great Western run from Paddington to North Road, Plymouth, 225¾ miles in 247 minutes. Then in order come—the North Western run from Euston to Rhyl, 209¼ miles in 237 minutes; the Midland run from St. Pancras to Shipley, 206½ miles in 245 minutes; the Great Northern run from Wakefield to King's Cross, 175¾ miles in 189 minutes; the Great Central run from Marylebone to Sheffield, by way of Aylesbury, 164¾ miles in 177 minutes; the Caledonian run from Carlisle to Perth, 150¾ miles in 180 minutes; the Great Eastern run from Liverpool Street to North Walsham, 130 miles in 158 minutes; and the London & South Western run from Waterloo to Bournemouth, 108 miles in 126 minutes.

Passengers on the North Eastern are quite overshadowed by minerals; while it carries ten times as many thousand tons of passengers as there are days in the year, it deals with almost as many million tons of minerals as there are weeks in it. Not only are the coals distributed inland, but they are shipped in large quantities from the North Eastern's docks. There is Tyne Dock, for instance, where they load a ship at the rate of 500 tons an hour and send away 6 million tons in twelve months. Then there are Blyth where the coal shipments are about half as great, though they have been going on for more than three hundred years; and Dunston where about half that quantity is shipped; and the Hartlepools, the fourth timber port in England, that ship the same quantity as Dunston; and in addition there are Monkwearmouth, Sunderland, and Hull. Tyne Dock, for the coals outwards and the timber, grain, hemp and flax, inwards, has sixty acres of water; Hull has a hundred acres for coals and forty for the timber trade; Hartlepool has eighty for coals and nearly sixty for timber; and there are thirty-two devoted to coals and iron at Middlesbrough, to which the Stockton & Darlington was extended in 1830, the docks dating from 1842, having been taken over by the railway ten years afterwards when the Cleveland ironstone had been discovered. Altogether the North Eastern's dock and shipping business adds £200,000 a year to its revenue.

Machine Shop at the Gateshead Works.

Those who are interested in steep gradients will find many of them on the North Eastern mineral lines, including several still too steep for locomotives. Near Battersby is the steepest, that at Ingleby, rising 1 in 6 for a thousand yards, a nice little climb of 500 ft.; at Waldridge there is one of 1 in 25 worked by wagons in trains of nine, the full wagons attached to a wire rope by means of which they haul up the empty ones, and so steadily do they work that they take down over 9000 tons a day. The steepest gradient used by passenger trains is that at Kelloe, between Hartlepool and Ferryhill, where the rise is 1 in 36 for three-quarters of a mile, and there is another almost as steep, 1 in 40, for two miles at Ravenscar. Some good climbing is done out in the west in Cumberland, where the trains go over 887 ft. on the Cockermouth line, which the North Eastern works jointly with the North Western, the junction being at Clifton, just short of Penrith.

Corridor carriages began in this country on the North Eastern, the first being a first-class put on the line in 1883. Something of the kind had already been used on the Continent, but this was in several ways an improvement, and it has been much improved upon since. Ten years afterwards dining-cars were attached to the afternoon express from King's Cross and the corresponding up express from Edinburgh, and then the coaches, all built as corridors except the dining-cars, which were open saloons, were connected by vestibules so as to admit of a free passage from end to end of the train.

It may be a small matter, but it is worth remembering that trains of this sort cost £12,000 each to build, and, with the more elaborate decoration, they cost more every year. Nowadays the North Eastern standard passenger coach is 53½ ft. long, the electric cars being 18 in. longer, but the largest coaches on the line are those of the East Coast Joint, which measure 65½ ft.

Third-class dining-cars are also due to the North Eastern, though they were not put on the line until a few weeks

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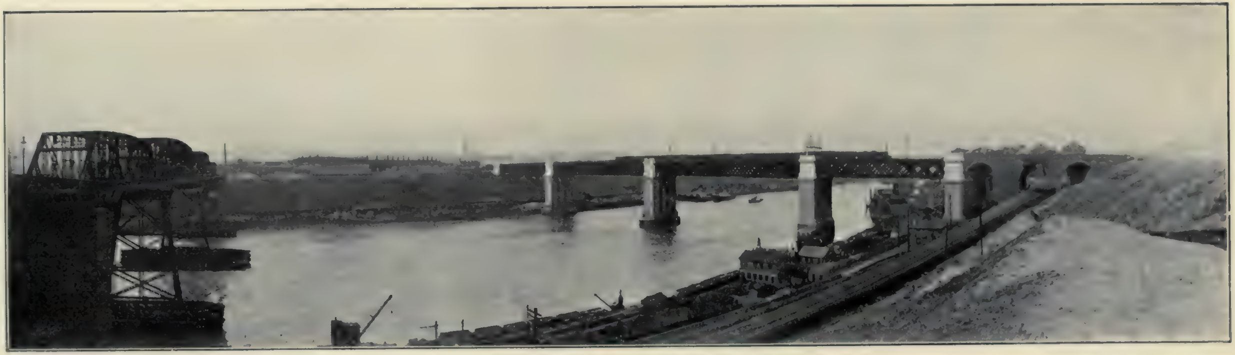
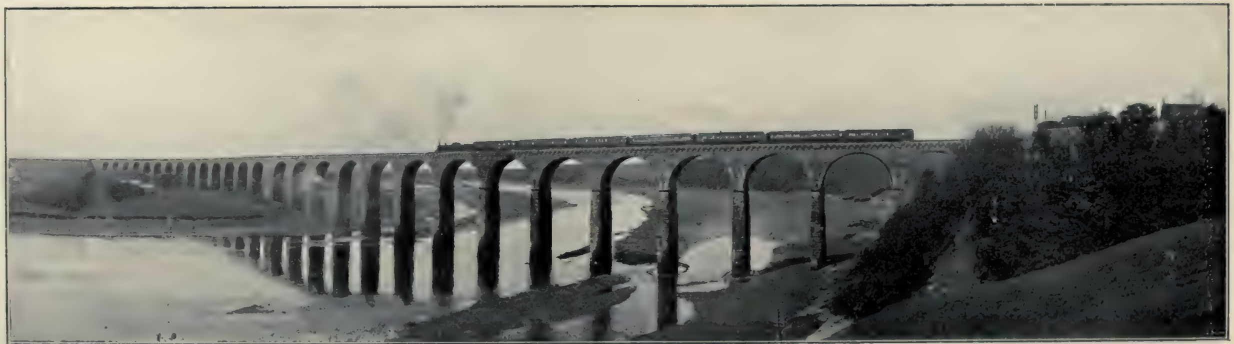


THE KING EDWARD VII. BRIDGE AT NEWCASTLE



THE ROYAL BORDER BRIDGE

after they had appeared on the Midland and West Coast. When they were decided on in 1891 the news got abroad, but the shops of the East Coast companies were too full of work to take them in hand, and the order had to be given out to a carriage building company that did not finish them within the time expected, the result being that though first in the field with the proposal the North Eastern was a month behind in the introduction. Another introduction of the North Eastern's in a smaller way, which has not, however, become general though its convenience is great, was that of the numbered duplicate ticket for cycles, the duplicate part being a tie label attachable to the machine, so that at the end of the journey the cyclist produces his ticket to the guard and there are no difficulties in identification.

The High Level Bridge at Newcastle.

The North Eastern has always considered the cyclist, and been happy in its efforts to encourage every other form of healthy recreation. Its excursion arrangements are almost as well thought out as those of the Scottish lines, but among its ticket novelties perhaps the boldest was the issue of coupons for a thousand miles during a year, each coupon being for a single mile, each book of a thousand costing five guineas; and during the first year there were sold no less than 4200 of these books of first-class travel at a 1¼d. a mile.

In several ways it is the most practical of our lines. Fortunate in its monopoly, it has done its best to develop its business without litigation; friendly with all the companies around, it has been generous in its interpretation of what is meant by running powers, and has lost nothing by doing so. No less than seven other companies run into York after traversing over twenty miles of North Eastern metals.

This running of one company's trains on another company's line may seem a simple affair, but it has to be paid for, and few are aware of the vast amount of work it entails behind the scenes. So far as passengers are concerned the visible sign of this is the ticket and the nipping. How often do we hear the holder of a frequently punched ticket complain of the damage the nippers have done! Little he thinks that every nip tells the Railway Clearing House the route by which he has really come.

It was in 1864 that the system of ticket-punching, by which a distinctive sign or number was allotted to the ticket-examining stations of the different lines, was adopted. On some lines groups of stations may have the same distinctive mark, while here and there an important station may use a group of a few numbers for more detailed identification. These marks and numbers are the postmarks of our railways; by them the Clearing House can tell how much the different companies that have carried the passenger have to pay each other for the use of their track and rolling stock, and just as coaches and wagons and sheets, and every consignment of parcels, goods, and minerals, are traced, so are the passengers, for it is not always the case that they travel by the way they should go or return when and how they should.

George Hudson, by his encouragement of through traffic by way of Derby and York, rendered the Clearing

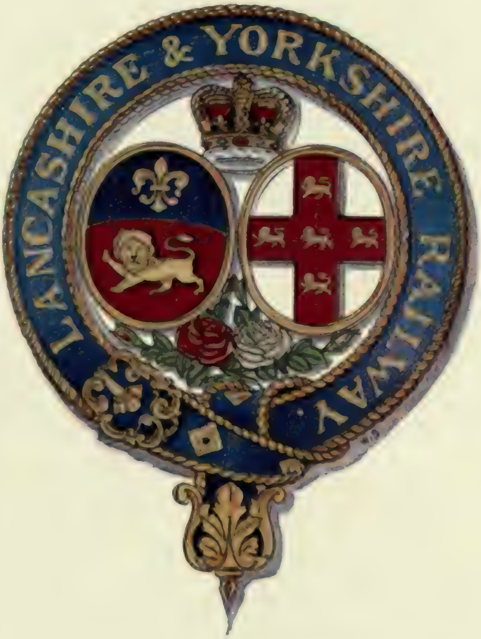
House necessary and first suggested it. Sir James Allport, then of the Birmingham & Derby, went a step further and proposed a system similar to that of the Bankers' Clearing House; Robert Stephenson, then engineer of the London & Birmingham, the Birmingham & Derby, and the North Midland, had the matter explained to him by Allport, and at once grasped its importance, and energetically supported it at a meeting of the Birmingham & Derby directors at which Samuel Carter, the solicitor of the other two companies, was present; and he and Carter brought the matter before the London & Birmingham directorate, with the result that the chairman of that company, Mr. George Carr Glyn, afterwards Lord Wolverton, became the first chairman of the Railway Clearing House, and appointed Mr. Kenneth Morison, then of the London & Birmingham, its first manager.

The Wheel Shop at Gateshead.

Morison organised it, and on the 2nd of January 1842 the Clearing House began business in a small house in Drummond Street near Euston Station, with a staff of half a dozen clerks who had a very easy time of it—for a few months. When the House celebrated its jubilee in 1892 it reported that during its existence the capital of our home railways had increased from £50,000,000 to £900,000,000, the miles of track from 1600 to 20,000, the passengers then numbered 800,000,000, the £195,000 of the first year had become £22,000,000, and — well, other details running into figures of which the ordinary mind has no conception. Suffice it to say that the House, now in Seymour Street close by, numbers its clerks by the thousand, with representatives at 500 junctions throughout the land recording night and day the number, owner's name, and destination of every wagon, coach, van, and tarpaulin that passes from one company's line to another's, while the staff at the House analyse and classify all their reports regarding the 17,000 stations, collieries, and sidings in the ten-volumed distance-book, and many other things, including the marks made by the ticket-nippers.

North Eastern Steamer preparing to leave for Rotterdam
Riverside Quay, Hull.

THE LANCASHIRE & YORKSHIRE



COAT-OF-ARMS

Victoria Station, Manchester.

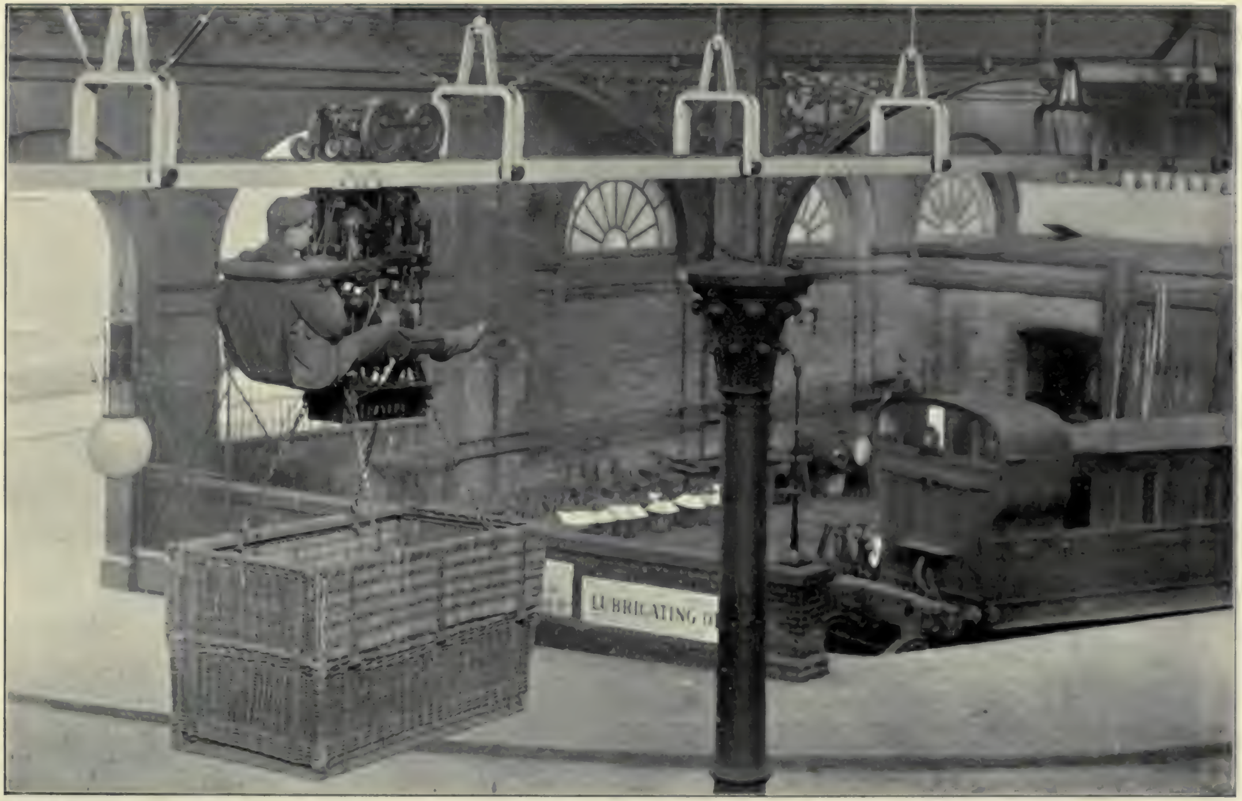
THE LANCASHIRE & YORKSHIRE

A GUARD in scarlet coat and tall beaver hat who starts the train with a tantara on a long coach-horn may seem rather out of place on a British railway, but it was with guards thus attired and equipped that the Lancashire & Yorkshire began.

On the 1st of March 1841 there opened the Manchester & Leeds from Manchester to Normanton, the nucleus of that entanglement of tracks extending from the Humber to Morecambe Bay which now occupies sixty pages of Bradshaw with its time-tables. There was bunting overhead; the engine was decorated. "At a few minutes before 9.15 a.m.," we read, "the clanging of the ponderous bell, which at this station is suspended in the roof, gave the signal for the carriage doors to be closed, or rather slammed. All being clear, the fanfare of the guard from aloft was quickly responded to by a piercing whistle amid the roaring steam of the engine, and the train proceeded swiftly on its way to the tuneful strains of a band, which was accommodated in one of the open carriages, accompanied by the exultant cheers of the throng of spectators. At Rochdale another band of musicians waited to accompany the train with the avowed object of playing the train through the tunnel." And, unlike other openings, all went well. "The average speed maintained to Normanton, exclusive of stoppages"—to evoke more cheering—"was at the rate of 30 miles per hour."

No wonder the people cheered, for they had been talking about this particular railway for sixteen years; never was there a line with better prospects of success. There was no difficulty about the choice of route, there was only one easy way through the boundary hills between the two counties, and it was agreed from the beginning, in 1825, that the line must go through the Calder valley; but it was not easy to raise the money. The Liverpool & Manchester, however, put heart into the scheme, and after six years the Manchester & Leeds Company was formed to introduce Bills that failed, through the opposition of the canal interests, in both 1831 and 1832. Then came what may be best described as three years of shifting and squaring, and then the obtaining of the Act in 1836 for a railway through some of the most populous districts in England. Look at the map and think of the people and goods waiting to be carried in and about that belt of towns.

Its engineer was George Stephenson, and among those who helped him was Alexander Nimmo, F.R.S., who was also engaged on the Manchester, Bolton, & Bury, now also part of the Lancashire & Yorkshire. A great man was Nimmo, an engineer who did much in Ireland and elsewhere and knew more than most men, though now nearly forgotten. He was one of Stephenson's supporters before the Commons Committee on the Liverpool & Manchester Bill. "Sir," he was asked, with regard to Chat Moss, "would you under-



AN OVERHEAD CARRIER—A NOVEL DEVICE FOR TRANSPORTING LUGGAGE AT VICTORIA STATION, MANCHESTER

take to float a railway over a morass ? " "Yes, sir," said Nimmo cheerily, "and I will undertake to float one over the sea, if you will find the money for it ! "

The works began on the 18th of August 1837. The ground was hilly and the rocks were hard, and people who knew nothing about engineering, among whom were most of the newspaper men, kept up a continuous chorus as to the impossibility of the endeavour. But Stephenson went steadily on with his easy gradients through magnesian limestone, coal measures and millstone grit, yoredales, and then millstone grit and carboniferous again, "cutting through them like cheese"—very hard cheese, with occasionally a soft patch of clay or shale where it was not wanted. Littleborough, 2885 yards long, was the most difficult tunnel made up to then. It was longer than Kilsby, and more than a thousand men were at work in it for four years. Thirteen stationary engines were engaged in hauling the stuff out of it, and 23,000,000 bricks and 8000 tons of Roman cement were used in its lining.

Beyond the great tunnel, the cutting had to be piled to obtain a firm foundation ; then came the short Winterbutlee tunnel, and the viaduct of eighteen arches leading on to the skew-bridge over the Rochdale canal to Todmorden on the county boundary, where the nine-arched viaduct carries the line 50 ft. and more above the old road. Two more short tunnels followed, and another viaduct leading to another tunnel, and at Charlestown there would have been another tunnel had it not been found better worth while to run the line in curves round the hill, thus setting the fashion so largely followed abroad. River, road, and canal were then crossed, and, through another short tunnel, Hebden Bridge was reached. Sowerby Bridge was similarly reached through another tunnel, and soon afterwards the numerous crossings of the Calder began. Passing Horbury, the Calder was diverted to save two bridges, and, passing Wakefield, the river was crossed for the last time, and the route was clear to the junction with the North Midland near Normanton after engineering works varied enough to satisfy even a Canterbury man.

In the whole fifty miles there were not four miles that were straight. The gauge, remarkable for a Stephenson line, was 4 ft. 9 in. to ease the running on the curves ; and the permanent way was similar to that of the North Midland with the parallel rails held in the chairs by a ball and key. Sleepers of larch were used on the embankments, and stone blocks from the cuttings to as great an extent as possible until the mistake was acknowledged. The engines were mostly Sharps or Stephensons, and were all 6-wheelers with 14 in. by 18 in. cylinders, and 5 ft. 6 in. driving wheels.

Provision was made for three classes of passengers, or rather four, for private carriages were carried on trucks at sixpence a mile, the people riding in them paying twopence a mile in addition. In the company's first-class coaches the fare was threepence a mile. Second-class people at twopence a mile were in coaches painted black above and dark green below, with red panels and red bearing springs, the roof being nearly flat, the seats being unpadded. There were three compartments, the two double seats having half backs from which an iron upright supported the roof, and under the seats were lockers for dogs or luggage.

There were quarter-lights on each side of the half-door, and these were fitted with sliding shutters which, when pulled along, met over the door, a remarkable arrangement that allowed no light to pass through the side windows except when it was shut out from what would now be the window in the door. At each end of the roof was a seat for the guard, whose scarlet coat, when new, must have cried out gloriously against the black and dark green.

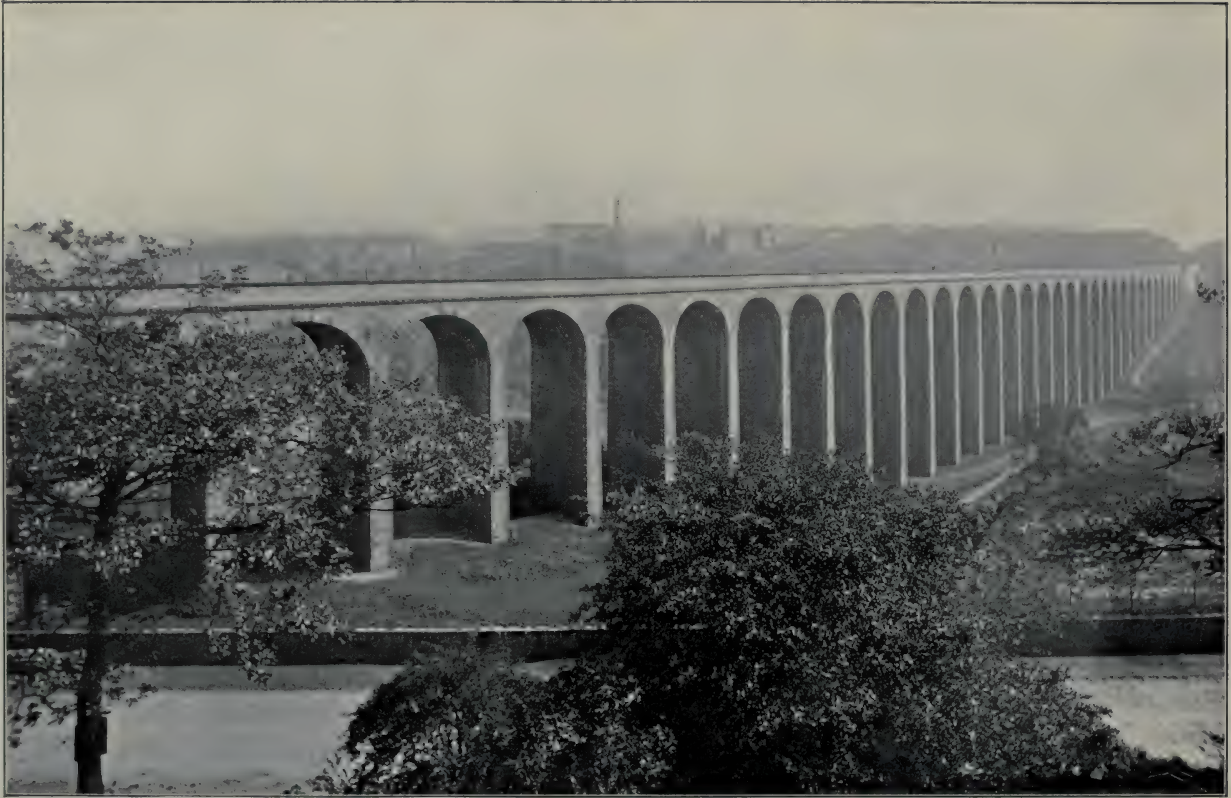
The wagons were merely open trucks with a handrail round them but no seats. The first great improvement was to bore holes in the floor to let the rain out, the next to run a wooden bar from end to end and another across for the passengers to cling to, the next to give them seats; then came the roof, then the sides were made up, with wooden slides for windows. "Wagon passengers" as they were called, not third class, were treated as undesirables and severely discouraged. The porters were not allowed to touch their luggage, and they had to be at the booking office at least ten minutes before the departure of the train or they would not be booked.

The Manchester and Blackpool Express.

As the Manchester & Leeds began with coach guards in all their latest glory, so it began, like other old railways, with coach booking on the latest principle. There was a book with counterfoils in which had to be written twice the passenger's name, with the date, the destination, and the fare, half the leaf being torn out and given to the passenger, the counterfoil remaining as the record. The passenger's slip when collected at the destination was stuck on a spike file, and with other such vouchers went to headquarters to be compared with the books. Booking a train was a long job even at a bye-station, such a station, for instance, as Milton, now Brampton, on the Newcastle & Carlisle, where the clerk invariably sought the better way and generally found it.

At Lancaster in 1792 was born Thomas Edmonson, an enterprising child who was taught knitting by his mother to keep him out of mischief. At Lancaster, Gillow the cabinetmaker was then making chairs as the firm had been doing for years, and are still doing, and keeping working drawings of every order so classified that then, as now, you can order, say, a couple of dining-room chairs as supplied in seventeen hundred and something, and in a fortnight the chairs come along matching exactly those that have been in the family for a century or more. Edmonson was apprenticed to Gillow and trained in thoroughly genuine work. He did well; he thought and he invented machinery and some things that had a large sale, and some that had a limited one, among the latter the combination apparatus by which the busy housewife could rock the cradle and churn the butter at one operation. "In due course," as it has been quaintly said, "he entered into business; though a Friend he was not successful;" and like many others who failed in business he obtained a situation on a railway—and he was sent to Milton to make himself useful in many ways, including this booking, which could not have taken up much of his time.

Occasionally he took a trip eastwards, and one day as he was walking in a certain field in Northumberland he reached a spot in that field, still pointed out, where an idea occurred to him. "Why all this fumbling and spelling of passengers' names? Why not treat them anonymously and number them? Why not a strip of paper or pasteboard printed with the names of station and class, with the fares? Why not consecutively number them for accounting purposes and date them on the day of issue to prevent fraud? Two machines could do it!"



THE LOCKWOOD VIADUCT, NEAR HUDDERSFIELD

And then he thought out the machines, and went to talk it over with his friend Blaylock the watchmaker.

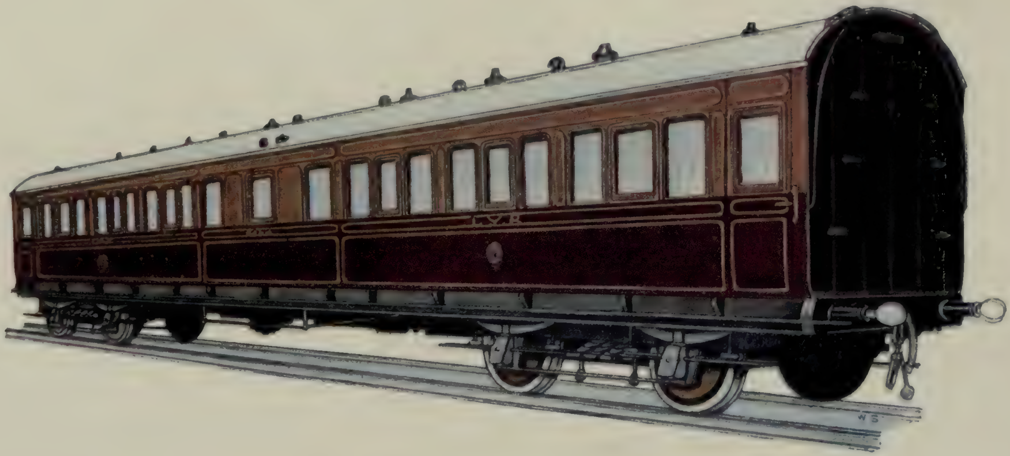
They made the machines, that was not difficult ; but to persuade a company to adopt the new system was another matter. The Newcastle & Carlisle would have nothing to do with it, and Edmonson tried elsewhere. He tried the Manchester & Leeds, and fortunately the manager was just in the mood to jump at it. The delay at the booking-office windows while the clerks wrote their fastest with spluttering quill pens and pencils that broke at the point had become exasperating. The " wagon passengers " were rough and noisy, and made merry over the coach-horns and jeered at the scarlet coats that had been ruined by the smuts in the tunnels owing to the guards having to sit on the tops of the carriages at all times and in all weathers ; and everything appertaining to the old coaching days had become abhorrent. New methods in all things were evidently needed for the new conditions. And thus it happened that Edmonson was permitted to give his invention a trial on a section of the line on his own terms of half a sovereign per mile of road per year.

That progressive engineer Captain William Scarth Moorsom (whose name it is as well to give in full to distinguish him from his brother, Captain Constantine Richard Moorsom of the North Western) was also applied to by Edmonson, and introduced the new tickets on the Birmingham & Gloucester shortly after they had got to work on the Manchester & Leeds ; and, the advantages being evident, the plan became generally adopted and spread with the railways all over the world. Edmonson's income grew with every mile, and the surplus he invested until he had accumulated enough to pay off his old bankruptcy creditors in full ; and then he started on another series of investments, all in railways, and became wealthy, as he certainly deserved to do. His younger brother George, of some note as an educationist, was also a railway-minded man, and introduced the study of Bradshaw into his famous school at Tulketh Hall, setting his pupils to work out problems in cross-routes and connections as being a better mental gymnastic than Latin or Greek.

There are over a thousand millions, that is more than five hundred acres, of tickets issued in this country during the year. They are packed in bundles of 250, and are numbered consecutively up to 9999, and then a new series begins if it does not begin before, but frequently they are not wanted in such numbers, and even only five of a sort have been printed. They are all of the same size to suit the printing machines, which print only one ticket at a time, but their colours and patterns are nearly as numerous as those of dress fabrics. The colours of the ordinary tickets of all the chief lines are given in the Railway Year Book, but these are only a fraction of the variety used. Some are used in millions, some not in tens. From one station the writer booked to a certain seaside resort soon after the branch was opened, and his ticket was 001; next year he went, and his ticket, very faded at the edge, was 002; next year the ticket, not quite so dirty, was 004. Four tickets in three years; that is the smallest number to his personal knowledge.

The tickets are placed in the tubes with the highest number on the top, there being at the bottom of the tube an opening just large enough for the lowest ticket to be drawn out. In fact it was the ticket tube that gave the hint for the automatic sweetmeat delivery stand which the ticket-printing machine somewhat resembles in shape, and this led back to the automatic ticket machine by which the Lancashire & Yorkshire sells 750,000 in a year.

The numbers of all the bottom tickets are taken before any are issued, and, as each ticket is sold the next is drawn just far enough forward to show the number. When the train has gone (or at any time that may be necessary) the numbers are taken down, and the old numbers being de-



THE LANCASHIRE & YORKSHIRE RAILWAY

THIRD-CLASS SALOON, No. 2509

Extreme length . . . 54′ Extreme width . . . 9′ Height from rail . . . 11′ 9⅜″
Seating capacity . . . 56 Centre corridor. Divided into two compts., with lavatory in each.
Incandescent gas lighting. Automatic vacuum and Westinghouse brakes.

ducted from them give the amount and details of the sales, and consequently the cash for which the issuer is liable. This is all done in the train books, the totals of which go into the summary book to give the day's total takings that are sent in the double-lidded boxes to the larger stations, or are paid into the bank or, at terminal stations, are collected by the bank.

Every month the starting and closing numbers of the tickets in every tube are entered in a book, a copy of which goes to the audit office ; and after collection at the destination every ticket is arranged in numerical order and sent to the audit office, whence all through tickets go to the Clearing House, to be dealt with according to their nips and punch-marks. Those who know these things and appreciate them keep their tickets as undamaged as they can ; the ignorant and the foolish do their best to make their tickets illegible, but, as we have said elsewhere, " with the spread of education and the increase of idiot asylums, such people become fewer, and every year there is a slight increase in the percentage of tickets returned from the collectors in good condition."

Among other novelties introduced by the Manchester & Leeds under Captain Laws was the first combined railway and steamboat long distance excursion ; and, considering it was the first, it took a deal of arranging. This took place during the Whitsun holidays of 1843 ; the train was worked through Normanton on to the North Midland, thence on to the York & North Midland, thence on to the Hull & Selby to Hull, where the steamer took the excursionists to Leith for Edinburgh—a really remarkable effort for those early days.

The Manchester & Leeds soon changed its name. In 1847 the company assumed its title of the Lancashire & Yorkshire on the first of that series of amalgamations which, with loops and spurs, have spread it across the two counties from Goole to Fleetwood, named, by the way, by Sir Henry Fleetwood after himself, he having planned the whole place on the site of a rabbit warren in 1836, formed the harbour and brought the railway to it, making it " a seat of commerce situated advantageously for intercommunication between the great marts of England and the seaports of the Isle of Man and the north of Ireland."

Of its extensions the best worth remembrance is that from Wigan to Southport through Burscough Bridge, which it built on compulsion. Before its opening the train took passengers to Euxton, and thence they had to make their way by coach. The Act for the continuation of the railway had been obtained for years, but, fearing it would not pay, the company did nothing, and it was not until a Southport man secured a mandamus compelling them to complete the line that they set to work on what proved to be the most profitable section of their system. The other Southport line, that from Liverpool by the coast, also proved unexpectedly profitable, and at length the traffic on it became so great that the only way to deal with it was by electrification.

One advantage was evident from the first. As Mr. John A. F. Aspinall pointed out, " Every time a locomotive train comes in and goes out you have four platform operations and eight signal operations. First of all the train comes in, then a locomotive follows it, that is two ; then the train goes out, that is three ; then the locomotive which brought it in goes out, that is four platform operations, which means eight signal operations. The electric motor train comes in, that is one ; the motorman goes to the other end of the train, and the train goes out, that is two. You have only two platform operations, and four signal operations. The result is that, by using motor-car trains instead of locomotives, you double the capacity of your terminal accommodation." Then there were other advantages, the quicker getting into speed and the higher journey speed, the more frequent service, the greater possible mileage of each train per day, and the increased loading and unloading capacity of the platforms. Against this were the expense of the installation and upkeep, and the unforeseen drawbacks. In short, it was a plunge, and it has proved to be a plunge that paid.

The Southport branch has fifteen stations on it and is 18½ miles long, and with 4 miles of four tracks, 25 miles of double track and the sidings, there are 77 miles of single track. All the four tracks were electrified, but although the frequency of the trains has been more than doubled, and the speed increased, the work is easily dealt with on the two lines of way; and the two western lines are left for steam locomotives only, for, as on the North Eastern, the mineral and merchandise traffic is worked in the old way, the passenger trains only being worked electrically.

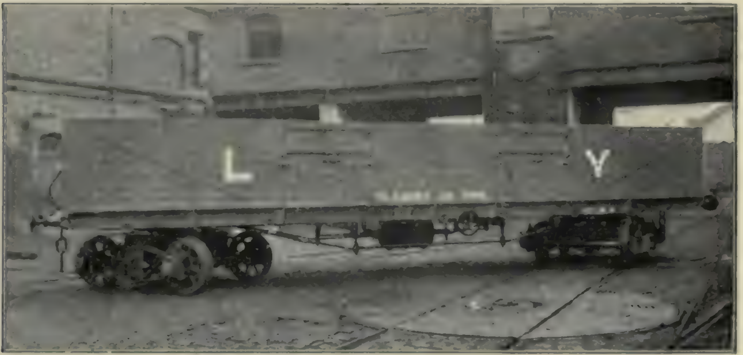
Express Passenger Locomotive No. 1510.

Before the change the Liverpool & Southport line required 30 engines and 152 coaches with 5084 seats; it now has 38 motor-cars and 53 trailers, giving seating accommodation for 5814. The trains work up into speed quickly, and in half a minute after starting are travelling 30 miles an hour; expresses do the whole distance in 25 minutes, but the stopping trains, with fourteen stops, take 12 minutes longer. The Lancashire & Yorkshire has its race traffic, and the running on the Aintree branch is a good example of what the new system is capable. On Grand National Day 13,000 people leave the Exchange Station at Liverpool for the course between 11.15 a.m. and 2 p.m., and these used to be taken in special trains holding about 500 passengers each. Unlike engines, the motors, as we have noticed, require no shifting and shunting, and the result is that with trains holding a few more passengers made up of the ten old coaches with four 150 horse-power motors, for which the only addition necessary was the running of a few cables over the roofs of the coaches to complete the electrical connection of the motor-cars, the traffic is worked more easily and quickly.

There is one drawback to electrical traction. According to the present law locomotives are not rated, but power-stations are, and heavily too ; consequently the site of a power-station requires consideration from one more point of view than would at first seem necessary. The power-station of the Southport line is at Formby, where are five generators, four of 1500 kilowatts and one of 750 kilowatts, and there are four rotary sub-stations and five battery sub-stations to deal with the fluctuations of the load.

The third rail, or conductor rail, stands 3 in. above the track rail, as is now the general practice arrived at by the meeting at the Railway Clearing House in March 1903 in order that electrically driven rolling stock can work over other companies' lines when required, the horizontal distance between the centre of the track and the centre of the third rail being the standard 3 ft. 11½ in. The fourth or return rail should be 1½ in. above the track rail, as determined at the same meeting, but on the Southport line this rail is below the level of the track and uninsulated, the current being returned through the wheels to the track and from it by means of copper bonds to the central fourth rail to which the track rails act as auxiliaries.

The rapid wearing away of the track rails and tyres is as noticeable on this as on other electrical lines, and according to Mr. Aspinall is probably due to the low centre of gravity of the motor-trucks throwing the pressure that should be borne by the tread on to the flange. At the same time it should be remembered that the ordinary permanent way, etc., on our lines, as a whole, costs on the average 15 per cent. per year for repairs, in other words wears out every seven years.



A 30-ton Swivel Goods Wagon.

The Lancashire & Yorkshire has over 1500 locomotives, that is more than the Great Northern, Great Central, South Western, Great Eastern, Brighton, or South Eastern & Chatham. Of these 1100 are in steam every day, and over a thousand of them have been built at Horwich. The works there are among the best in the country, and cover 116 acres, of which over twenty-two are occupied by the buildings, among them the splendid erecting shop 1520 ft. long. They were begun in 1886, and the first engine was completed in 1889.

This was Mr. Aspinall's 8-wheeled passenger tank with a radial box at each end, a 2–4–2, the first of a class of which no less than 270 have been built, which run more than half the passenger engine miles. A class of engines that run 7½ million miles a year is worth making a note of. They haul trains of 270 tons at an average speed of 36½ miles an hour over some of the steepest grades on one of the most difficult lines in England. They carry their 1540 gallons of water in side and back tanks, and take it up when running either way by a vacuum apparatus worked from the brake, for the Lancashire & Yorkshire was the first company to follow the North Western in laying down water-troughs, and has them at about a dozen places on their complicated system of which the two busy areas communicate by the neck through the dividing range. The cylinders, inside with top valves, are 18 in. by 26 in., the coupled wheels are 5 ft. 8 in., the radial wheels 3 ft. 7¾ in., the boiler is 10 ft. 7⅜ in. by 4 ft. 2 in., the 220 1¾-in. tubes have a heating surface of 1108·73, and the firebox one of 107·68, while the grate area is 18¾ sq. ft.

Mr. Aspinall's policy was to have as few classes as possible and to favour standardisation and interchangeability. The result is that there are only fifteen classes of engines, excluding pug engines and rail motors, now on the line. The second group was his 6-wheeled goods engines, of which the first of the 440 appeared in September 1889. These are hauling goods trains weighing 760 tons, and come in useful for passenger work during the excursion season. Their cylinders, wheels, tubes, and grate area are similar to those already given, but their boilers are 10 ft. 9¾ in. by 4 ft. 6 in., and their total heating surface is 1193. In going-away times they have a lively freight behind them. A Lancashire operative, or rather the thousandth part of a mixture of a thousand Lancashire operatives, for there is no such individual as an average man, is proficient in humour best describable as broad and homely, and undoubtedly loud, which finds its best expression in a trip to Blackpool, the English Coney Island.

Aspinall's 8-wheeled bogie passenger engines, 40 in number, followed these. According to Mr. Hughes, the

Chief Mechanical Engineer of the line, whose excellent paper is the authority for the details of its present locomotives, "they were designed to work the fast passenger traffic between Manchester and Southport, Manchester and Liverpool, Manchester and Blackpool, and Manchester and Leeds, and have similar cylinders to the goods engines, and unbalanced valves. When designed, they had the largest coupled driving wheels in this country, namely, 7 ft. 3 in. diameter. The tenders are interchangeable with those of the goods engines. The maximum loads hauled are 220 tons at an average speed of 42·8 miles per hour."

The Locomotive Erecting Shop at Horwich.

The next class of importance is that which was introduced in October 1891, of which there are 20 hauling loads of 1000 tons on the level. These 6-wheeled coupled outside cylinder shunting tank engines have 17 in. by 24 in. cylinders, 4 ft. 6 in. wheels, a heating surface of 1167, a grate area of 17 sq. ft., and a tank of 980 gallons. In March 1899 came the first of 20 Atlantics, the largest inside-cylindered engines of the type then built by us. The cylinders of these 4–4–2's were 19 in. by 26 in., and steam jacketed, the bogie wheels were 3 ft. 0½ in., the trailing wheels 3 ft. 7¾ in., and the coupled wheels 7 ft. 3 in.; the boiler was 15 ft. long and 4 ft. 10 in. in diameter, the heating surface of the 225 2-in. tubes was 1767, that of the firebox being 161, and the grate area 23 sq. ft. They had Richardson valves exhausting through the back, and one of them was fitted with a superheater. Twenty more of these were built, having no jackets to the cylinders, five of them having superheaters. These forty engines are hauling trains of 375 tons, the fastest and heaviest on the line, no less than 23 trains a day between Liverpool and Manchester doing the distance, 37 miles in 40 minutes, at the rate of 55·4 miles per hour. The distances on the Lancashire & Yorkshire are not unlike those on the Brighton, the longest non-stop run being the 48 miles between Wakefield and Manchester, but the goods traffic is half a dozen times as great, and the road almost as many times as difficult, being among other things more undulating—between Shawforth and Britannia, for instance, on the Bacup and Rochdale branch, where it reaches its summit level, it rises to 965 ft.

In 1900 the first of 108 8-wheeled coupled coal engines was set to work. These have Belpaire fireboxes. Similar to these came a class of 21 in March 1903, fitted with corrugated flue boilers. The cylinders are 20 in. by 26 in., the wheels are 4 ft. 6 in., the boilers are 12 ft. 9 in. by 5 ft. 5¼ in., and the 280 2-in. tubes have a heating surface of 1775, that of the firebox being 125, the grate area being 26. In 1899 Mr. Aspinall became general manager, and was succeeded by Mr. Hoy, who left in 1904 to be manager at Beyer's. He built 220 engines at Horwich, among them those just mentioned, the first of which was designed by his predecessor. In 1903 he built his first 10-wheeled radial tank for working the Oldham branch, where the gradients are 1 in 41 and there are eight stations in 7¾ miles, thus requiring an engine that will get into speed quickly. These 2–6–2's have 19 in. by 26 in. cylinders, the radial wheels being 3 ft. 7¾ in., the 6-coupled wheels 5 ft. 8 in., the 239 2-in. tubes having a heating surface of 1877, and the firebox one of 168, the firegrate area being 26·05, and the tank holding 2000 gallons.

In 1904 Mr. George Hughes succeeded Mr. Hoy, and he built the thousandth engine at Horwich, a compound with four cylinders, the two high-pressures outside the frames and the two low-pressures inside. In 1905 he introduced his 8-wheeled radial tanks with Belpaire fireboxes. They are similar to the older type, but have boilers with a fifth more water and two-fifths more steam space. Six of the old round top firebox type he fitted with the Druitt-Halpin thermal storage tank, distinguished by the cylinder mounted on top of the boiler, which has proved an advantage on rising gradients though making very little difference elsewhere. In 1906 he fitted two standard goods engines with Schmidt's superheater, replacing their 18-in. cylinders by 20 in., and, this being an improvement, five passenger engines and twenty new goods engines are now working with the appliance, which weighs two tons

Automatic Ticket-Issuing Machine.

but increases the tractive force in a greater degree than the adhesion.

In March 1908 came the first of his 10-wheeled banking engines, 0–8–2, with the largest cylinders, 21½ in. by 26 in., used until then in our simple engines. The coupled wheels of these are 4 ft. 6 in., the radials 3 ft. 7⅝ in.; the boiler is 13 ft. by 5 ft. 8¼ in., the heating surface of the 295 2-in. tubes is 2008, that of the firebox being 190; the firegrate area is 25·6, and 2000 gallons of water are carried. In these engines a reversion to an old practice was adopted, the two inner pairs of driving wheels being without flanges and having the tyres wider than the others so as to allow of curves being more easily negotiated.

The 4-cylinder bogie passenger goods engine introduced in June 1908 will be our last example of the locomotives of the Lancashire & Yorkshire. The four cylinders of this 4–6–0 are 16 in. by 26 in., the inside pair working on the leading axle, the outside pair on the second axle. The wheel base, 25 ft. 4 in., was kept short by placing the inside cylinders in advance of the bogie centre, and flexibility was obtained by giving three-sixteenths lateral play to the trailing wheels and fitting the coupling rods with ball-and-socket joints. The bogie wheels are 3 ft. 0½ in., the coupled wheels 6 ft. 3 in.; the boiler measures 15 ft. by 5 ft. 8¼ in., the grate area is 27 sq. ft., there are 295 tubes of 2 in. outside diameter as in the other engines, and these give a heating surface of 2317, the total heating surface being 2507 when that of the firebox is added. The engine, which weighs over 77 tons, is very steady and smooth running owing to the ingenious arrangement of balancing reciprocating parts by opposite reciprocating parts and revolving weights by revolving weights.

Horwich is approached by a branch between Bolton and Chorley. It is well in the centre of the western division, of which Hellifield is the farthest north and Liverpool the farthest south. The eastern division covers a much narrower strip of country stretching across to the Humber. On the North Eastern, by means of running powers, the L. & Y., as it is nearly always called, reaches York from Normanton, and Hull from Goole ; on the Great Northern, from Askern, it reaches Doncaster ; on the North Western, from Bradley Wood and Heaton Lodge, it reaches its detached territory between Huddersfield and Penistone ; and on the Great Central, from Penistone, it reaches Sheffield. Manchester is its centre, and Liverpool, Fleetwood, and Goole its chief ports, though the line to Fleetwood and Blackpool, and the other stations north of Preston, it owns jointly with the North Western.

Goole was a village, where the Dutch river enters the Ouse, until 1820, when the Act was obtained authorising the canal from Knottingley ending in two docks, one of which was opened in 1825 and the other in 1826. Two years after the opening of the second dock it had thriven sufficiently to be made a Customs port, and for seventeen years it slowly grew. Then, in 1845, came the Wakefield, Pontefract, & Goole Railway and Aire & Calder Navigation Act to construct further docks, and thenceforth it increased in prosperity at a quicker pace ; and now it has eight docks and sidings for four thousand wagons, and eighty goods trains go out of it a day. When the Lancashire & Yorkshire absorbed the railway it did its best to foster the trade of the canal port, and by this policy it was led on to have ships of its own. In 1905 it bought the fleet of the Goole Steam Shipping Company, and to this in the following year it added the Goole boats of the Wholesale Co-operative Society ; and now it has twenty-six steamers trading between the Humber and the Continent, at Liverpool it has three trading with Drogheda, and at Fleetwood it is joint owner with the North Western of seven more, trading to Belfast, Londonderry, and the Isle of Man.

Meat, fish, milk, special goods trains of all kinds are now run on our railways, but every one may not have heard of butter trains. Every Sunday there comes into Goole a cargo of butter, which is unloaded and sent off in two trains at two in the morning to reach Manchester at five, and be delivered to the traders at seven. The wagons are but a few among the 32,500 owned by the company, which uses them during the year in hauling about some 7 million tons of merchandise and over 18 million tons of minerals along its 585 miles of track ; and every year it carries 60 million passengers in its 4800 coaches, its passenger mileage being about 13 millions. What this means can be best appreciated by comparing it with the South Eastern & Chatham, which has a longer line by 44 miles and a passenger mileage of 12 millions. In short, the Lancashire & Yorkshire takes more money for each mile of track, and runs its engines more miles on each mile than any other of the great companies, and its coaches and wagons—some of them of 15, 20, 30 tons or more—would form a train that would reach from Liverpool to the Spurn.

The L. & Y. Steamer *Mellifont.*

Marylebone Station.

THE GREAT CENTRAL

The Great Central, formerly the Manchester, Sheffield, & Lincolnshire, originated with the Sheffield, Ashton-under-Lyne, & Manchester, the Act for which was obtained in 1837. The route of this, 40 miles long, was from Spital Fields, Sheffield, to a junction at Manchester with the Manchester & Birmingham, now part of the North Western.

The Sheffield line, as it was called for brevity, which enters Yorkshire through the Woodhead tunnel, proved a severe trial in many ways, financial and otherwise, to Joseph Locke, the engineer, his most troublesome endeavour being the piercing of the Pennine range. In doing this two tunnels side by side, a few yards over three miles long, had to be driven through the tough millstone grit. The first, begun in October 1838, was not finished until December 1845; five years were spent in making the second, which was begun in 1847; and much relieved were the proprietors, and their creditors, when the seemingly impossible was accomplished.

In 1846, the great amalgamating year, the Sheffield followed the fashion during the railway fever, and acquiring the Great Grimsby & Sheffield Junction, the Sheffield & Lincolnshire, and the Grimsby Haven Company, became the Manchester, Sheffield, & Lincolnshire. And it went on acquiring local line after local line until it became a system of some extent doing very good work, its particular business being the collection of traffic for the greater companies to run to London and elsewhere, favouring first one and then the other according to the terms obtainable. The policy was persisted in for years, until, being barely profitable, owing to the heavy load of the capital account, the company tired of it and resolved to come to London as the Midland had done.

The extension was all the more attractive to the shareholders as forming part of a great scheme for linking up the line with the Metropolitan, the Chatham & Dover, and the Channel Tunnel, Sir Edward Watkin being interested in the four companies; but that ambitious project had to be laid aside. There was much opposition from the companies with whom the M. S. & L. proposed to compete, but after many rebuffs it managed to get the Act for the southern extension in alliance with the Metropolitan, and promptly changed its familiar name, of which there was nothing to be ashamed, in the hope that its days of struggle were over.

It had lived and grown, but not thriven, on competition amongst others, and now the competition was to be direct and keen. As, however, the manager naïvely remarked, "we have taken every advantage of the experience of other railway companies," and with a new line, new rolling stock, and the most intelligible of time-tables, there was a fair but distant prospect of success; but another era of amalgamations or friendly alliances is opening, and the burying of the hatchet in the interest of everybody, even the traders, has brought the Great Central to act in alliance with the Great Northern and Great Eastern, whether the working union be recognised officially or not.

Mottram Viaduct over the Etherow.

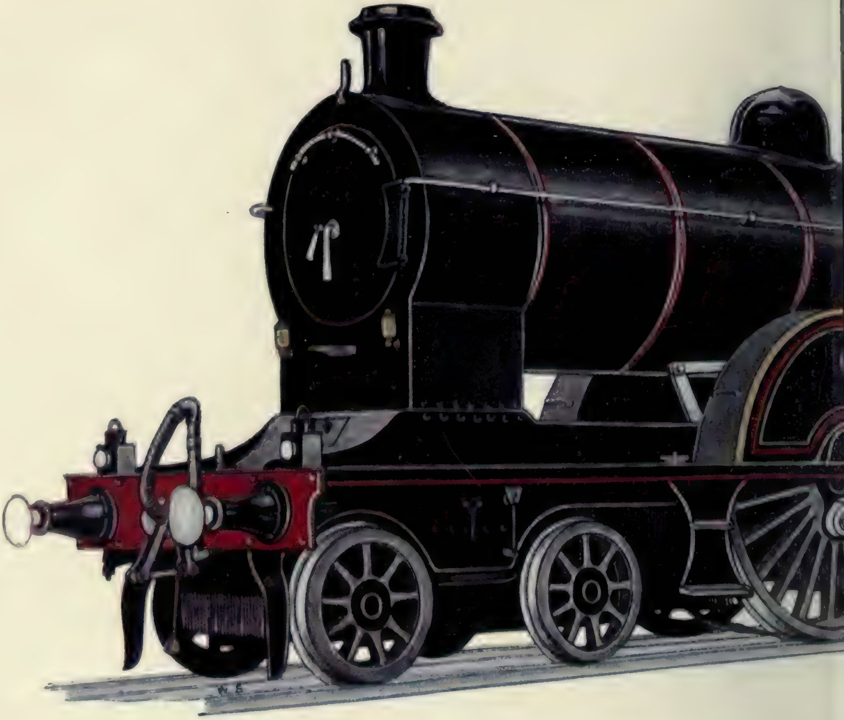
It has 726 miles of its own. By the terms of the Act its first station out of London has to be west of the River Brent. At Neasden the line forks, one branch going to Harrow, the other to Northolt, the Harrow branch being continued over the joint Great Central and Metropolitan to Quainton Road, where the joint ownership ends, the south branch continuing over the joint Great Central and Great Western through High Wycombe, and at Ashendon—where the new Great Western route to Birmingham goes off—running on to Great Central metals to join the other half of the loop at Grendon Underwood. Thence northwards, with the exception of an important branch to

Banbury and Stratford-on-Avon, it runs right away, with no extension east or west, through Leicester and Nottingham to Heath, where a loop goes off to Chesterfield to join the direct line again and continue to its old territory.

At Godley it enters on the Cheshire Lines (a partnership of the Great Central, Midland, and Great Northern), which take it to Southport, Liverpool, and Chester. At Glazebrook it enters on a line of its own to Wigan and St. Helen's, and through Chester it obtains admittance to the lines it bought in the Wirral peninsula. From Chesterfield a loop goes off to the east, taking it through Lincoln and Market Rasen to Barnetby and back by Frodingham and Doncaster to Mexborough; whence by short lines, and the Great Central and Great Northern Joint, it obtains access to Wakefield and Leeds. Within the loop are a few connecting lines. From Frodingham it reaches Barton-on-the-Humber, and through Barnetby it runs to New Holland, where in 1846 it bought the ferry-boat and became the first railway company to own a steamship; and farther east it continues to Grimsby, its own peculiar port.

Grimsby, recognisable from afar by its water-tower 300 ft. high, which has a tank of 26,500 gallons giving the pressure of 100 lb. to the square inch that works the dock gates, etc., is just within the Humber. From the gallery of the tower you can see it all. Below are the docks, over a hundred acres of water in them; the Fish Docks to the left, the Royal Dock in front, the Alexandra to the right with its elbow towards the town station. To the east is Cleethorpes, the terminus of the Great Central in these parts; to the west is the new dock at Immingham; to the north across the estuary is Spurn Head.

There have been fishermen at Grimsby ever since Havelok the Dane was a baby, for it was a Grimsby fisherman who found him adrift in a boat in the Humber, "purposely exposed as it should seeme to the pittylesse of the wilde and wide ocean," as Gervase Holles puts it; and at the Norman

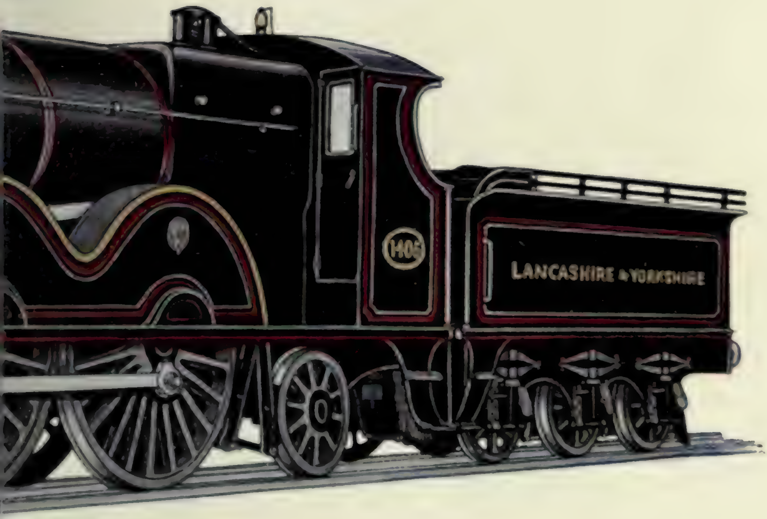


THE LANCASHIRE &

EXPRESS PASSENGER

DESIGNED BY MR. JOHN

BOILER	Length	15′ 0″	**FIRE BOX**	Length	7′ 5⅝″
	Diameter	4′ 10″		Width	3′ 2½″
CYLINDERS	Diameter	19″			
	Stroke	26″			
			HEATING SURFACE	Tubes	1767 sq. ft.
				Fire box	161 ,,
TUBES	No.	225			



ORKSHIRE RAILWAY

OCOMOTIVE, No. 1406

F. ASPINALL, M.INST.C E.

DIAMETER OF WHEELS
Bogie . . . . . 3′ 0½″
Coupled . . . . 7′ 3″
Trailing . . . . 3′ 7¾″

WORKING PRESSURE 180 lb. per sq. inch.

GRATE AREA . . . . . 23 sq. ft.

WEIGHT OF ENGINE & TENDER IN WORKING ORDER
89 tons 8 cwt. 1 qr.

WATER CAPACITY . . . 2290 galls.

COAL CAPACITY . . . . . 5 tons.

Conquest it was a borough of the Crown. It managed to exist for centuries in a very quiet way, and then, between 1796 and 1800, its first docks were built at a cost of £70,000, but the rate of progress proved disappointing until the present system of docks was begun by the M. S. & L. in 1852. Attracted by easy terms and efficient management, representatives of the fishing trade at other ports transferred their headquarters to so advantageous a position, and from the small beginning of 453 tons in 1854 Grimsby has become the largest fishing port in the world, its last year's business amounting to no less than 173,735 tons.

Hawarden Swing Bridge over the Dee.

It is more than a mere fishing port, for coal exports and timber imports also keep it busy, and the general shipping business is large. In and out with quick despatch is what a transhipment trade requires, and for that style of thing there could be no better training than the fish business as dealt with on the Grimsby pontoon.

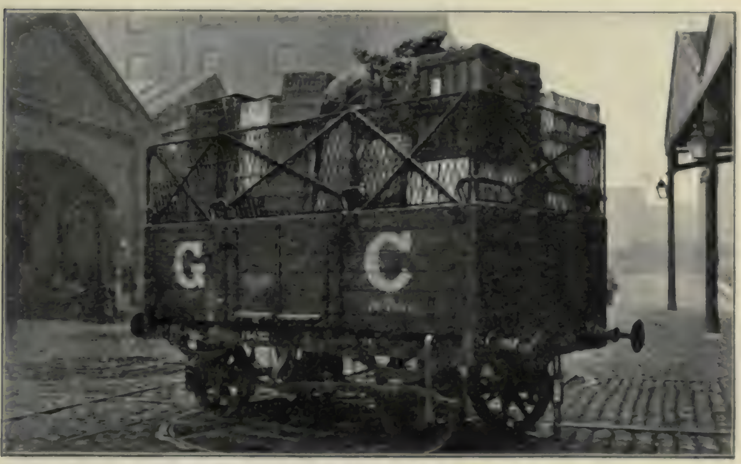
This pontoon is the quay by the side of the Fish Docks, really a long, covered platform with the fishing craft on one side of it and the railway lines on the other. The boats come in during the four hours the tide serves, and are placed bow on to the quay, close up, with barely a foot between them. No matter what time they may arrive, there they wait side by side, with their bows in a line—half a mile of steamers worth, say, £5000 each—until five o'clock in the morning, when they start unloading for the sale which begins at eight.

Such a quantity of fish as the writer saw laid out when he visited Grimsby he had never seen before. Cod and halibut, skate and turbot arranged in rank and file so that every fish could be seen and quantities easily counted, and haddocks and smaller things coming ashore by the basketful to be piled up in the boxes the fishmongers receive with about half as much in them.

At eight o'clock all was clean and orderly. Then the bell rang and the salesmen took up their positions among the fish to sell those caught by the line by English auction, and those caught by the trawl by Dutch auction in which the auctioneer drops the prices, the lot going to the first of the crowd who speaks. Porters placed their feet between the lots to mark them off, and round them and the salesmen crowds quickly gathered.

Ring, ring went one bell ; clang, clang went another. There were crowds all along the line. Louder and louder grew the uproar until it became tumultuous, and the busier the scene the dirtier it got. All the time the fish were coming ashore over the bows, quivering, gasping, writhing in barrels and baskets ; and as they came out some of the ice came with them, to be gathered in nets and washed in the dock and taken in again ; and other ice went in, crushed ice by the sackful and big blocks that went sliding across the pontoon from the carts on the land side, for the boats go out laden with ice and return laden with fish.

By noon the selling was over, and the pontoon gradually took on the appearance of an ordinary bank at a goods station, with packages of all sorts and sizes dumped around pillars with the names above of railway centres and railway routes. From the heaps the railway vans were loaded, and at 4.40 p.m. the first train left, to be followed by eight more, the last going out at a quarter to nine. As Billingsgate opens at five and Grimsby at eight, anything short in London can be ordered by wire to Grimsby, which can deliver to customers direct during the day if necessary. It is not, however, to London that Grimsby fish mainly goes, but to the Midlands and the North and West, even to Holland and Germany ; and the fish comes from as far as the Faeroes and Iceland and the White Sea, some of the steamers going a thousand miles from home in its search.

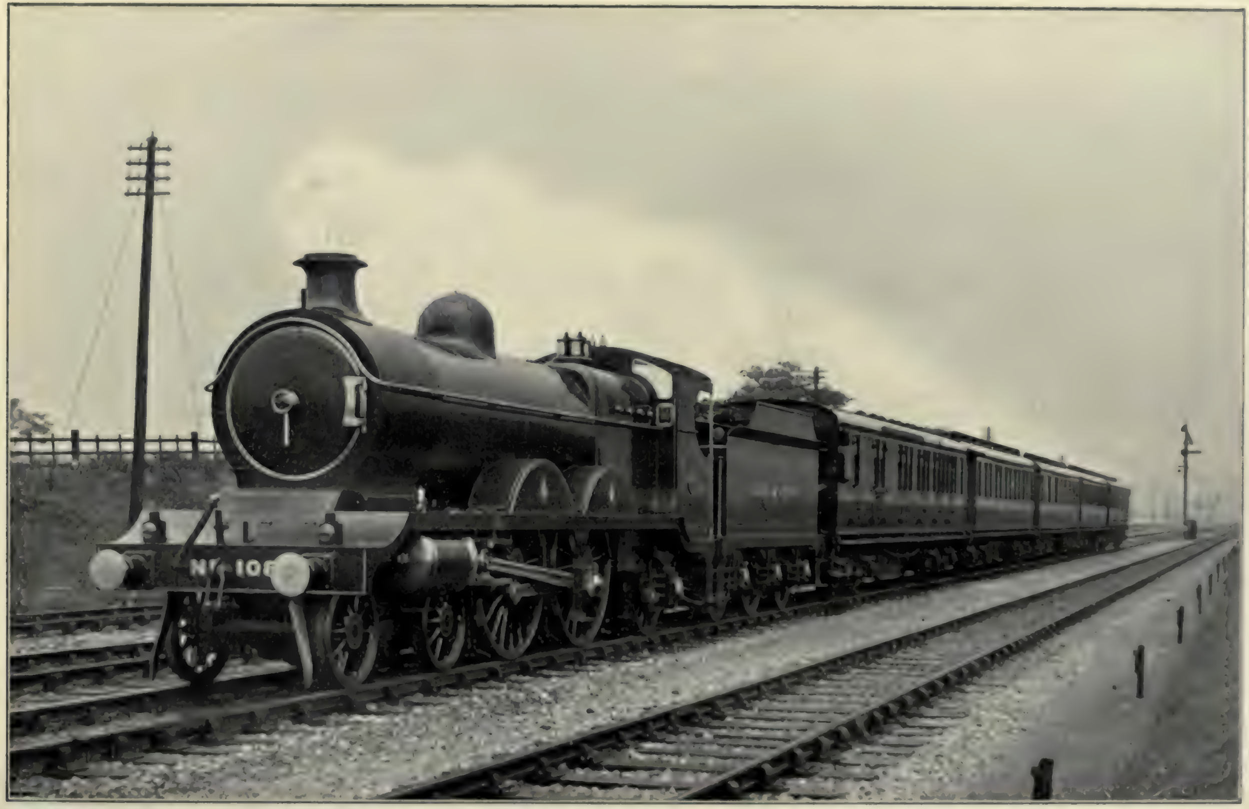


Wire Extensions to Goods Trucks for Bulky Loads.

The Great Central handles its other imports as smartly as it does the fish, and, in the Royal Dock and the Alexandra Dock, there is always plenty to do, for, as a nucleus of the shipping trade, it has a fleet of its own plying to the Continent. These and the Wilson boats and others bring in quantities of timber, barley for brewing, butter and eggs, cheese and margarine, onions and fruit and game (white Russian hares and Norwegian ptarmigan), and other miscellaneous things that are kept on the premises as short a time as possible. In the old days most of this got on to the Great Northern in the course of distribution, and it was in connection with that company that the M. S. & L. did its best work.

The Great Central joins the Great Northern at Retford, but the Manchester trains to King's Cross were brought on by it to Grantham, farther south ; and on this division of the journey the 56½ miles are fairly easy. It was on this London to Manchester route that the two companies ran what was at the time the fastest train in England, as already noticed ; a really good piece of work considering the gradients and impediments of the Sheffield to Manchester section. From Manchester to the eastern end of the Woodhead tunnel, which is about 1000 ft. above sea-level, is 23 miles, the gradients varying from 1 in 100 to 1 in 200, say an average of 1 in 120 all the way ; between the tunnel and Sheffield the down grades are mostly 1 in 120 and 1 in 130, and, on this side in particular, colliery and other junctions are numerous and the journey requires careful handling, the 41 miles of the original line being against fast running. The direct southern route from Sheffield is also unsuitable for rapid travelling as far as Annesley, to which it reached in 1892.

Starting from Annesley, the new line, which was opened for passenger traffic in March 1899, runs mostly at 1 in 176, crossing the Bulwell viaduct of 26 arches, continuing over sixty arches and bridges through Nottingham, and over arches and bridges at Leicester for a mile or more. Thence, by Rugby, where it crosses the North Western by a bridge more than 200 yards long, it goes over Charwelton, Culworth, and Helmden to Quainton Road, where it is at the same level as at Leicester. At Grendon Underwood, just before reaching Quainton Road, the alternative route goes off through High Wycombe on the Great Western joint line to continue on Great Central metals from Northolt to the junction at Neasden. From Grendon Underwood the eastern line is practically level to Aylesbury, where



THE MANCHESTER EXPRESS, NEAR WEMBLEY

it begins to rise for 14 miles, much of it at 1 in 117, to Amersham, whence it runs down to Rickmansworth at 1 in 105, then up to Northwood, down to Neasden and up to Willesden Green.

Just before reaching West Hampstead there is a gradient of 1 in 97—a mere trifle to that on the Brymbo branch, which is 1 in 35—and under the northern end of Lord's cricket ground there are three tunnels. Of the other tunnels besides the Woodhead there should perhaps be mentioned the Catesby of 2997 yards, and the Bolsover, 2624 yards, now on the Great Central owing to the acquisition in 1907 of the shortlived Lancashire, Derbyshire, & East Coast. Speaking generally, the Great Central is a 1 in 176 line, just as the Great Northern is a 1 in 200 line.

The colours of the M. S. & L. engines were green with black bands and white lining, the passenger engines of the Great Central are green with brown frames and splashers, the goods engines being black with red lines. As a whole, they are a powerful, good-looking, interesting lot that should be noticed at greater length than space here permits, more especially those designed by the present locomotive superintendent, Mr. J. G. Robinson ; but they were not all built at Gorton, for, amongst others, when "the Dukeries" was taken over in 1907 its 37 engines were added to the general stock and renumbered.

One of the most noteworthy of the newer engines is the 3-cylinder 0–8–4 tank, hauling trains of 960 tons up a gradient of 1 in 107 at Wath sorting sidings between Doncaster and Barnsley. The three cylinders of this are each 18 in. by 26 in., the 8-coupled wheels are 4 ft. 8 in., the bogie wheels are 3 ft. 7 in. ; the boiler is 15 ft. long and 5 ft. in diameter, and the 221 2-in. tubes are over 15 ft. 4 in. long, their heating surface being 1778 sq. ft. The firebox has 153 sq. ft., so that the total heating surface is 1931, the grate area being 26. Of this giant, the working pressure of which is 180, the tank holds 3000 gallons and the bunker 4 tons. The drawbar pull, up to ten miles an hour, is 13 tons. The weight, empty, is 74 tons 1 cwt., and when loaded that weight becomes 96 tons 11 cwt. The length over buffers is 45 ft. and the wheel base is 30 ft. 8 in.

Amongst the other tank engines mention should be made of No. 1120 and her sisters. These are 4–4–2's for passenger work. They carry 1825 gallons of water and 4½ tons of coal, and weigh when loaded 71¾ tons. Another class of tanks began with No. 1055—also 4–4–2's, with 18 in. by 26 in. cylinders, 3 ft. 6 in. bogie wheels, 5 ft. 7 in. drivers, and 3 ft. 9 in. radials; the boiler is 10 ft. 10 in. by 4 ft. 2 in., there are 185 1¾-in. tubes, their heating surface being 1030, that of the firebox being 110, and the grate area amounting to 19·85. These engines take 1450 gallons of water and 3½ tons of coal.

Of tender engines there is the 8E class of 3-cylinder compounds. These are 4–4–2's, the cylinders being 19 in. and 21 in. by 26 in., the low-pressures being outside. The coupled wheels are 6 ft. 9 in. in diameter. The total heating surface is 1931 sq. ft., of which 1778 are provided by the tubes; the grate area is 26, and the working pressure 180. The tank holds 4000 gallons, and the length of engine and tender over buffers is 61 ft. 10 in. The engine weighs 72 tons 16 cwt., and with the tender the total weight is 116 tons 19 cwt. These are the engines on the Sheffield expresses. Among the goods engines are the 4–6–0's, working at 180 lb. These have 19¼ in. by 26 in. cylinders, the coupled wheels being 5 ft. 3 in. Their grate area is 23·4 sq. ft., and the heating surface is 1909·5 sq. ft. The total weight of engine and tender is 111 tons 11 cwt., the tank holding 4000 gallons. Notwithstanding the size of the tenders, it may be as well to say that the Great Central picks up its water from troughs like other companies, the troughs being of steel plate 14 ft. 6 in. in length, riveted together by butt strips, being 874 yards long and 16 in. wide at the bottom, and along the full length runs a 1½-in. steam-pipe to keep the water clear of ice in frosty weather.

The largest stations are at Manchester, Sheffield, Nottingham, and Leicester; these, like the Cheshire Lines terminus at Liverpool, being really central, and from the central positions of its stations the line is said to have taken its title. When it changed its name it changed its colours, the new, roomy, comfortable coaches having their upper panels painted light grey and their lower panels chocolate picked out with gold lines. Smart they looked, but perhaps too smart to be recognised, for the grey and brown have gone and the coaches are now back again in the plain varnished teak of the M. S. & L.

Van for the Carriage of Cold Storage Goods.

They are seen in many places, for the line's cross-country services are its present distinguishing feature. You find them at Llandudno on the North Western;

Aberystwith on the Cambrian; Swansea, Cardiff, and Torquay on the Great Western; Bournemouth and Southampton on the South Western; and at Hull, Scarborough, and Newcastle on the North Eastern; Halifax and Blackpool on the Lancashire & Yorkshire; and many other stations where least expected. In its 1500 coaches it carries 24 millions of passengers a year, and in its 35,000 wagons deals with $25\frac{3}{4}$ million tons of minerals and $5\frac{1}{4}$ million tons of merchandise, while the yearly mileage of its 1200 engines totals up to 16,645,000.

The Coal Drops—Grimsby Docks.

Piccadilly Circus Station.

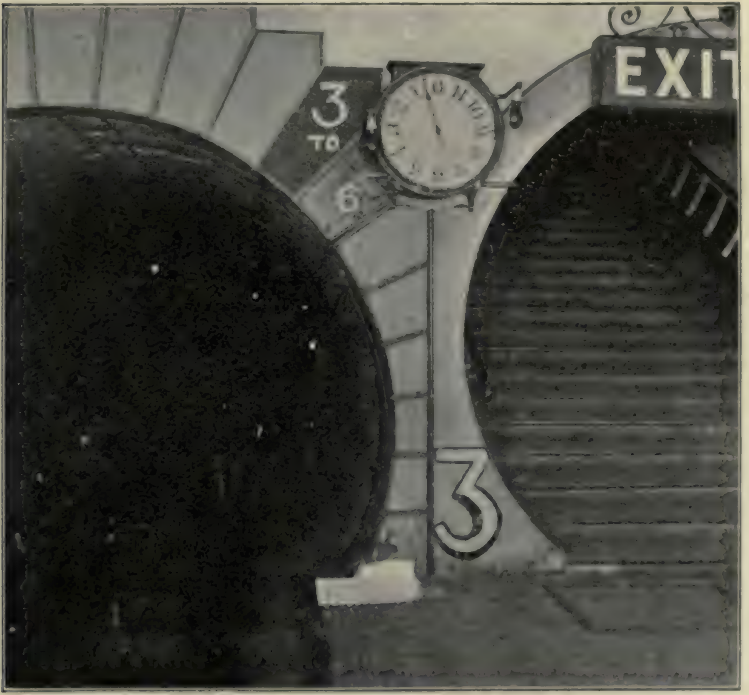
THE UNDERGROUND ELECTRIC

The Metropolitan, with which the Great Central was in such close alliance when it first came to London, was opened from Bishop's Road to Farringdon Street in 1863. It was the boldest railway venture up to then undertaken ; and its construction was as delicate as a surgical operation, owing to the network of pipes and drains beneath the streets amid which it had to be driven in its cut-and-cover advance. It quite swept away the prejudice against tunnels, and never afterwards did we hear of reports as to the salubrity of this or that railway through a hill, though never, before or since, was such an atmosphere provided for passengers.

Its first Act was obtained in 1853 when it was to be the North Metropolitan, the Act of the following year changing its title by the omission of the North, and it was to run from Paddington to the General Post Office. The proposed City terminus was very soon shifted to Farringdon Street, and the Great Western in consideration of the advantage of getting into the City subscribed £175,000 of its capital. To suit the Great Western it was laid with the mixed gauge, broad and narrow, but, as the Great Western worked it, only the broad gauge was used, until, as already related, the quarrel took place resulting in Sir Myles Fenton and Mr. Sturrock proving too many for the Paddington directorate.

Piccadilly Circus—Great Northern, Piccadilly, & Brompton Line.

The Act required it to be worked without its atmosphere being polluted with steam or smoke, and Sir John Fowler designed for it the strangest locomotive on record to comply with these provisions. This was the hot-brick engine. There were to be boilers at each end of the line to boil the water, and furnaces to make the bricks red hot. The trial trip took place on the 28th of November 1861, the start being made from Bishop's Road. The hot water was poured in, and the hot bricks were stowed in the fire-box and round the boiler, and, with a few open trucks, away she went. "A cloud of smoke, dust, and steam," says the report, "soon covered the train and continued until it emerged from the tunnels into the open air"—and it only just got there. In fact it was a failure, and the Great Western had to work the line as arranged until engines of the ordinary sort, with modifications, could be built, which, as it happened, were not ready until the underground battle of the gauges had been decided.

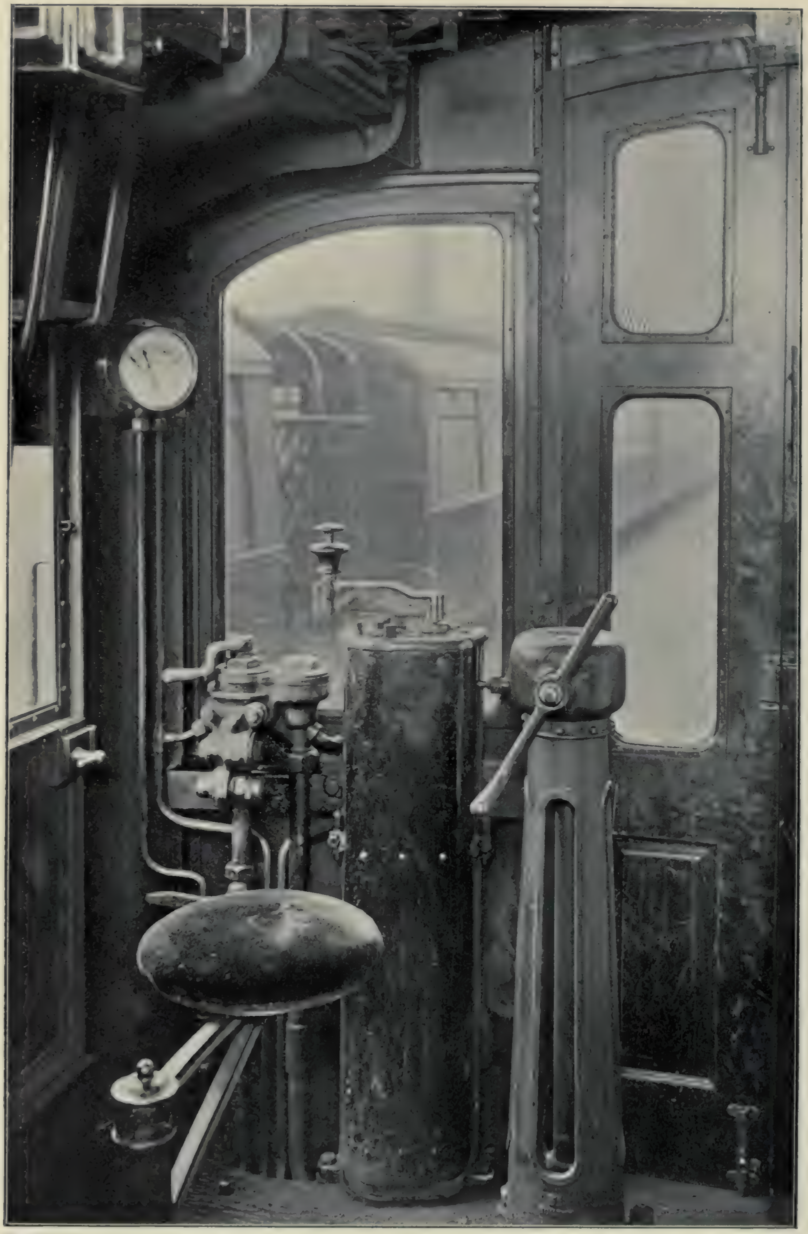


The Headway Clock at Trafalgar Square.

Extensions, small in length and great in cost, soon began. Citywards the line went on to Moorgate Street, now the largest station, where nearly a thousand trains run in and out during the day ; then, after a considerable interval, it extended to Bishopsgate and to Aldgate. In partnership with the Great Western it reached Hammersmith ; and it started on the St. John's Wood line, made by a separate company of its own formation, of which the continuation took it out into the country to end in Buckinghamshire. It is now 46 miles long, with its trains travelling 4 millions of miles during the year, carrying 81 millions of passengers, 2 million tons of minerals, and about 800,000 tons of merchandise. Those who knew the dingy, smoky Metropolitan in the steam era will hardly recognise it since electrification has made it the most convenient of the underground lines.

The District, really the Metropolitan District, which, to begin with, called itself the Daylight Route, and was almost as bad, has been similarly improved. It opened in December 1868 from High Street, Kensington, to Westminster Bridge, the connecting link between Praed Street junction and High Street being made by a separate company that was soon absorbed. In 1870 it was extended to Earl's Court, where it owns most of the land, and leases from the Midland the rest, on which the exhibitions are held. From Earl's Court its continuations have taken it to Addison Road, Putney Bridge, Hounslow, and South Harrow. The Embankment extension was opened to Blackfriars in May 1870. Next year the District reached the Mansion House, and in 1884 the City Lines and Extensions, a joint enterprise with the Metropolitan which cost a million a mile, took it to Aldgate to complete the Inner Circle ; and thence it has gone on jointly with the Tilbury & Southend to Bow. It is 25 miles in length, and its trains travel 3 million miles in a year and carry 56 millions of passengers.

Electricity on railroads had been talked about for years. In September 1842, Robert Davidson had on the



THE DRIVER'S CAB, SHOWING THE DEADMAN'S HANDLE

Edinburgh & Glasgow an electro-magnetic locomotive running on four wheels, and weighing five tons that went at a speed of four miles an hour. Current from batteries was, however, too costly for everyday working, and nothing more was done until the dynamo was introduced. In 1879 at the Berlin Exhibition Werner Siemens began electric traction as we now know it, and four years afterwards the first electric railway opened in the British Isles —the Portrush & Bushmills in the north of Ireland.

Then came a development which affords yet another instance of the unexpected. The Greathead shield was invented for making tunnels, and the inventor searching about for something to use it for, decided on running a cable tramway under the Thames from the City to Southwark. Fortunately he failed in raising the capital, but Mr. C. G. Mott, then a director of the Great Western, was induced to take an interest in the matter, and, after consideration, he recommended that an electric railway should be substituted for the cable tramway. By his influence the needful funds were subscribed, and in 1884 the City of London & Southwark Subway obtained its Act. It was a mile and a quarter long, the terminus being at the Elephant. In 1887 another Act was obtained by which it went on to Stockwell and became the City & South London, which a few years afterwards reached Clapham Common.

Deep down in the earth, far below all drain and pipe troubles, owing to its having to go under the bed of the Thames, the shield worked admirably. The tunnel tube is in sections of the circumference bolted together ; when the first excavation has been made, and enough room afforded for the shield to begin its work, a steel cylinder overlaps the end of the tube ; at the front end of the cylinder is the shield, beyond it is a series of cutters, and behind are hydraulic presses that push it along. The stuff cut away is brought through the doors in the shield, and the tube sections are put into place as it advances.

The circle cut being a trifle larger than the tube, a narrow space is left between the tube and the surrounding earth which is filled up with the blue lias grouting driven in by compressed air.

This tunnel-making made easy proved as successful as was anticipated, and the South London went ahead satisfactorily, even through the sand and water met with between the Oval and Stockwell. When the line was completed, further work was found for the shield in making the Blackwall tunnel; then it went on to the Central London, and thence to the other London tubes, all of which are traceable to the need of finding something for it to do.

The South London is the pioneer line and must be gently dealt with. With its extension to Euston it is eight miles long, the same length as the Hampstead; the Piccadilly being a little over nine miles, the Central London seven, and the Great Northern & City but three. It carries 21½ millions of passengers a year. Though of standard gauge, it is of small dimensions, and, when it was opened, its carriages were of the type generally associated with a journey to the interior of the earth. Those now in use are better, but the rolling stock compares unfavourably with that of the other subterranean lines in which the tunnels are of greater diameter. Unlike the other lines, the trains are worked by electric locomotives, which have to be shunted and otherwise handled as if driven by steam.

The South London has its generating station at Stockwell. The Central London—once, but no longer, known as the Twopenny Tube, it having abandoned the uniform fare—has its generating station at Shepherd's Bush, the Metropolitan has its own at Neasden, but all the other so-called Underground Railways receive their current from the mighty station whose four tall chimneys make Chelsea discoverable from every part of London.

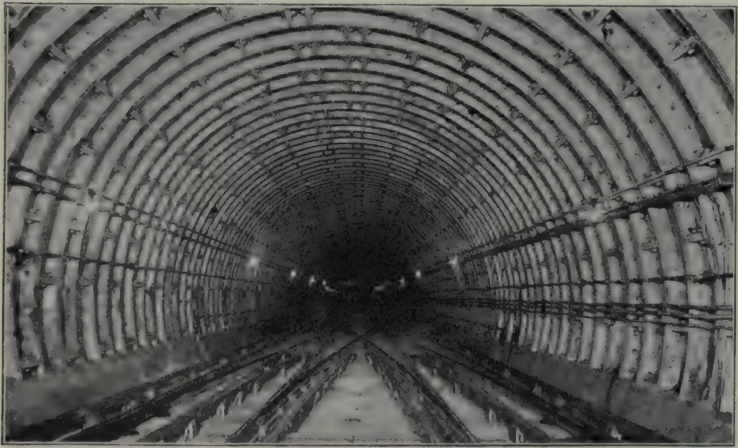
The work done by these tubes is becoming prodigious. The Underground, for instance, is carrying 240 millions of passengers a year. The Baker Street & Waterloo, between 7.30 a.m. and 10.30 a.m. and 5 p.m. and 8 p.m., is running trains every hundred seconds; and the Hampstead is running them every eighty seconds, and keeping good time owing mainly to the system of automatic signalling adopted on these lines, one of the noticeable features of which is the headway clock working backwards and showing the interval that has elapsed since the departure of the preceding train. And not only is there this clock, going a dozen times as fast as any other, to tell the driver for how many seconds ahead the road is clear, but in his cab is a telephone by which he speaks to the stations on either side of him. He drives the train by the deadman's handle, so called because it ceases to act, and the train stops, as soon as his grip of it fails. These, too, are the lines with the lifts that let out first those who enter first, the liftman

In the Signal Box—Holborn & Strand Branch.

touching a catch which frees a pneumatic arrangement by which the rear gates open automatically.

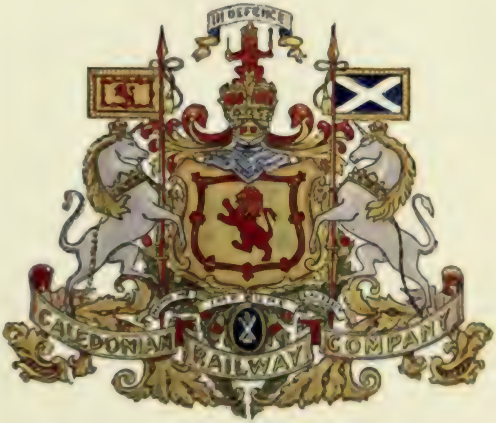
The South Western tried to get into the City sixty years ago, and it got there when in 1907 it bought the Waterloo & City. This is an electric line whose rails extend for two miles, and whose passages end opposite the Royal Exchange in the very centre of London.

Waterloo is also served by the Baker Street & Waterloo, which begins at the Elephant and ends at Edgware Road. This is over five miles long, and forms part of the Underground system. By it the man with a handbag is put in easy and direct communication with the Great Central, the Metropolitan, the Central London, the Piccadilly, the South Eastern, and the District, and if he cares to change and change can reach every London terminus, as indeed he can do by any of the others if he thinks it worth while.



The Crossover at Finsbury Park.

THE CALEDONIAN



CREST &
COAT-OF-ARMS

Central Station, Glasgow.

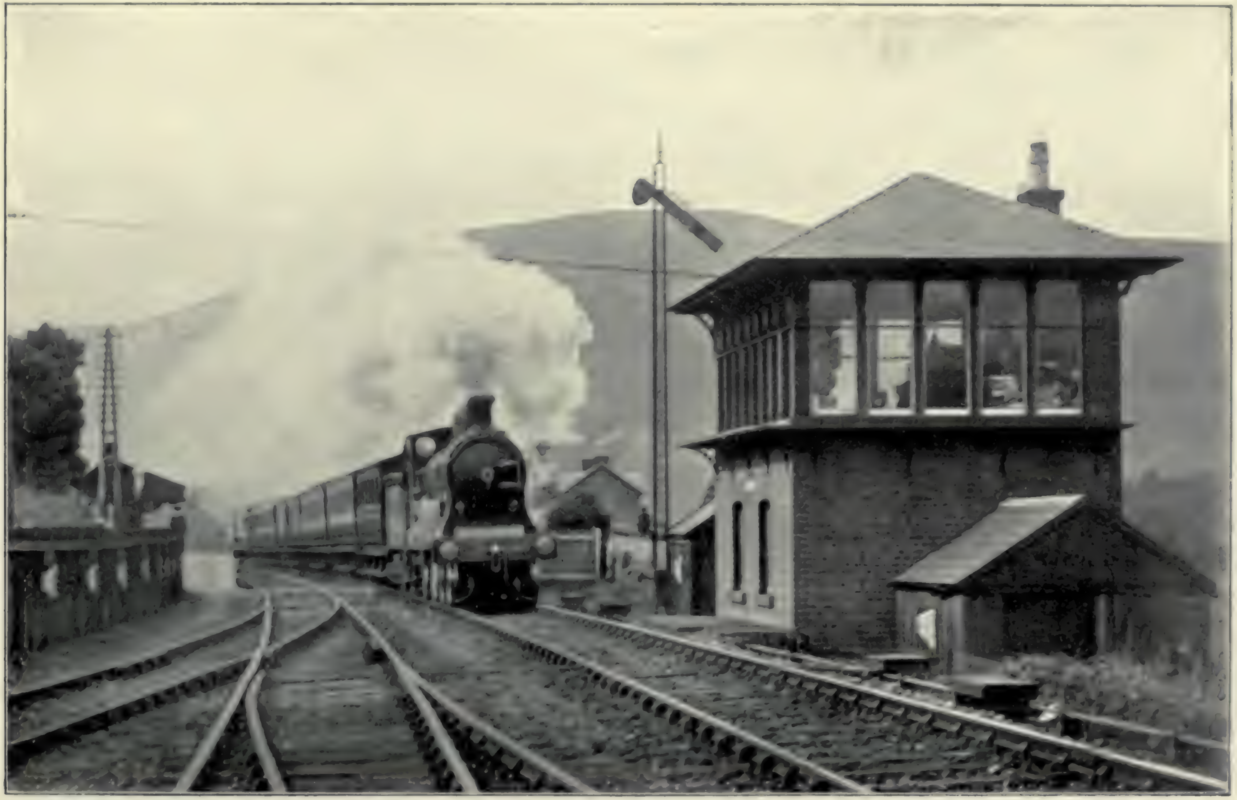
THE CALEDONIAN

SCOTLAND has ten railways, and if put end to end they would extend for 3843 miles, of which no less than 2267 would be single track. Four of them are short local lines working independently and of little importance; the others are the Caledonian, Glasgow & South Western, Great North, Highland, North British, and the Portpatrick & Wigtownshire worked by a joint committee which has not an engine of its own. The Caledonian, which comes first in alphabetical order, may be dealt with first, especially as at the time the Act was obtained it was believed to be impossible that there should ever be more than one railway from England into Scotland, the Caledonian beginning in England. And that was no longer ago than 1845. In the course of its development it has absorbed the successors of several of the old wagonways besides the Pollok & Govan referred to in the introduction, but for present purposes we may take it as originating with the line by which it first obtained access to Glasgow. This was the Glasgow & Garnkirk, opened in 1831, the Act for which, like that for the Dundee & Newtyle, dates from five years before.

Garnkirk is some seven miles eastward of Buchanan Street, Glasgow, and the line which ended at Canal Street, just behind St. Rollox, was 8¼ miles long. It came from Cargill colliery near Gartsherrie, on the Monkland & Kirkintilloch, opened in October 1826, and now part of the North British, and it ended at St. Rollox because of the canal and the chemical works into which it ran its coal wagons to tip their contents through trap-doors into carts waiting below; the wagons returning laden with Glasgow goods to be put on the Forth & Clyde canal at Kirkintilloch, thus avoiding the Port Dundas cut.

The first Glasgow terminus was Townhead, a stone hut about 9 ft. square and high, and from it five passenger trains left daily in the summer and four in the winter, business being done on artificial-light saving principles, the number of passengers in and out averaging 200 a day. The line was laid with fish-bellied, wrought-iron rails on stone blocks; it cost £40,000; and George Stephenson supplied the first two engines, the one bearing his name being a 4-coupled, and the other, the St. Rollox, a low-bodied, long-chimneyed single with 11 in. by 16 in. cylinders, and 4½ ft. driving wheels.

Another railway, the Wishaw & Coltness, authorised in 1829, came to join the Garnkirk on its way, and it was to Garriongill on this line that the Caledonian was brought from Carlisle in the first section of its own making. This measured 84¾ miles; the second was the Edinburgh branch from Carstairs, which measured 27¼ miles; and the third, known as the Castlecary branch, filled in the 10 miles between Garnqueen Junction with the Monkland & Kirkintilloch, 52 chains north of Gartsherrie and Greenhill,



A WEST COAST EXPRESS, AMONG THE LOWLAND HILLS

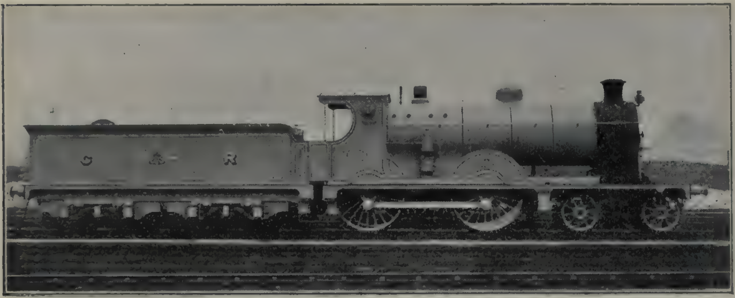
where it joined the Scottish Central, thus completing the 122 miles authorised by the Act.

It had been long in arriving. The real trouble in the background was that there were two projects, the other being the one that had been under consideration for years in Glasgow, and has developed into the Glasgow & South Western, which was all Scottish, whereas the Caledonian was of English origin, and began with the Grand Junction. In 1835 that enterprising company sent their engineer, Joseph Locke, to survey for a line between Preston and Glasgow by way of Carlisle. Locke worked right and left of Telford's coach road as far as Beattock, and, thinking the rise too great, he returned to Gretna and went up Nithsdale. In his report he recommended the route by this valley, and over the Cumnocks and onwards through Beith and Paisley.

This did not suit the Annandale landed proprietors; and it is a noteworthy fact that, broadly speaking, in England it was the landowners who opposed the railways, in Scotland it was the landowners who favoured them, while the landless were indifferent or antagonistic. Mr. J. J. Hope Johnstone, who owned more land in the Annandale district than any one else, sent a copy of the report to his factor Charles Stewart; and Stewart, seeing that a railway through the property would increase its value, persuaded him to take action, the result being the formation of the Committee of Annandale Proprietors in 1836, to whom the carrying through of the Caledonian project was mainly due.

Glasgow formed an opposition committee to support the Nithsdale scheme as against what had come to be called the Central; and to end the matter a proposal was accepted to have both routes gone over by different engineers, John Miller for Glasgow surveying Nithsdale, and Locke making a resurvey of Annandale. As might be expected, Miller approved the road down the Nith, and Locke found reasons for a not very enthusiastic support of the road up the Annan.

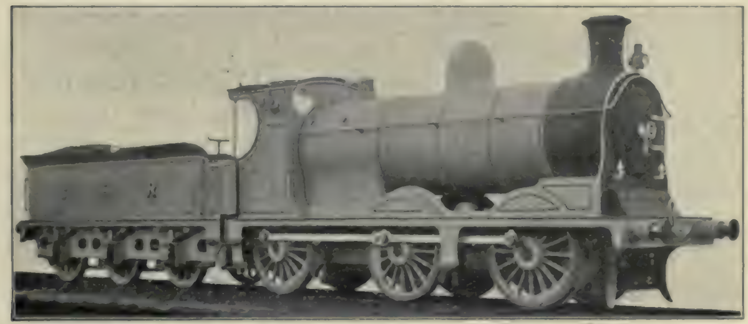
It was not so much the rise to Beattock summit that made him doubtful, but the descent from that point "in which there is more danger," though "perfect machinery," otherwise brakes, "and perfect watchfulness on the part of the attendants leave no room for apprehension." But at the same time he warned those who paid him his fee that "a plane like this ought not to be adopted without sufficient reason: you cannot expect it to be so economically worked, nor so certain in its operation as a line of equal length that is free from such a plane"—a fact the Caledonian is never likely to forget, though such gradients are not quite so much dreaded by engineers as they were then. Finally, Locke, to clear himself of responsibility, remarked that, as it might be considered a subject of national importance, it would not be a bad idea if Government were to institute an inquiry into the matter.



Express Passenger Engine No. 142.

The suggestion was eventually acted upon, and after an elaborate examination of the various proposals for railway communication between England and Scotland, the Board of Trade reported in favour of the Annandale route. But the opponents were not willing to give in, and after four years' further resistance, parliamentary and otherwise, during which the line became known as the Caledonian and assumed the Scottish arms, the Act was obtained, and the works, under Locke with Thomas Brassey as contractor, were soon in hand.

The same year, 1845, Locke and Brassey began to make the Scottish Midland, the Scottish Central, and the Clydesdale Junction. Next year the Garnkirk and the Pollok & Govan were bought. In 1847 the main line was opened to Beattock; the year afterwards it was complete to Edinburgh, Glasgow, and Castlecary; and in 1849 the Wishaw & Coltness was absorbed. Thus the road was cleared to Greenock and Paisley and Glasgow, and, by way of Castlecary and the Scottish Central, to Perth, and thence on to the Scottish Midland and the Aberdeen.

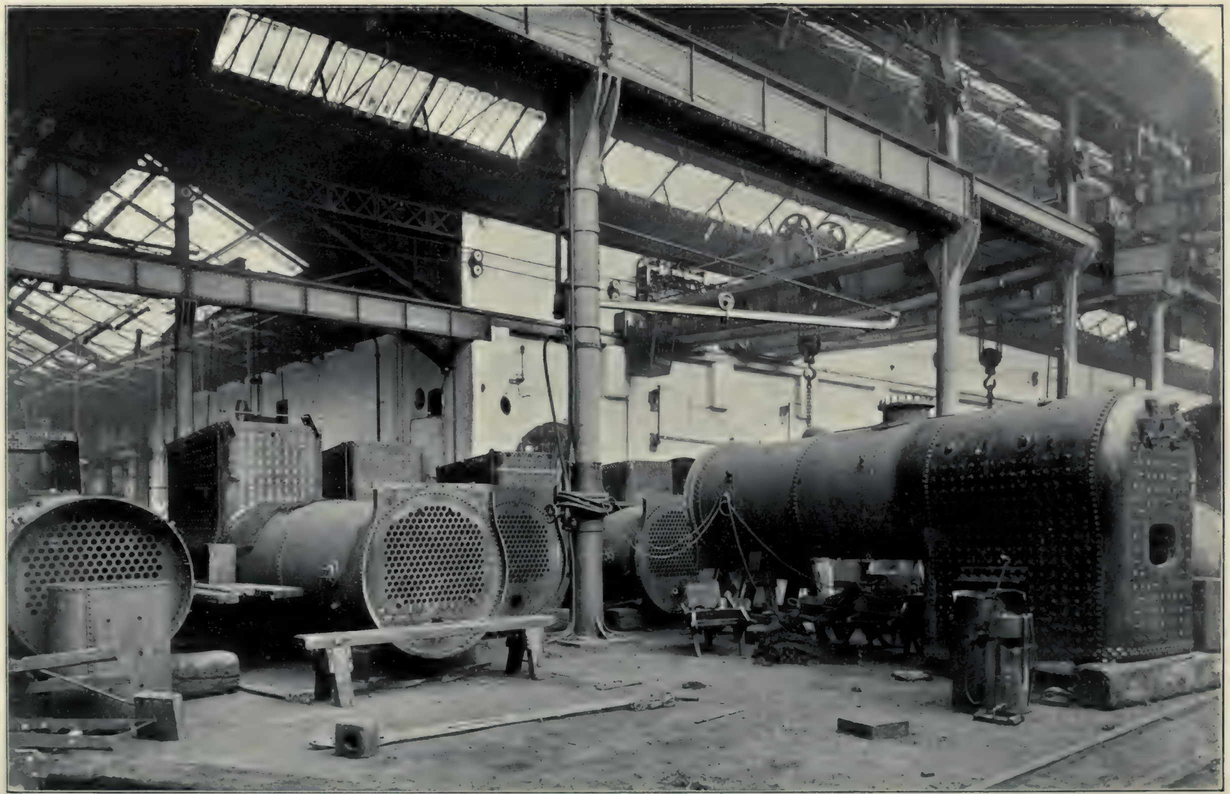


Latest type of Goods Engine, No. 664.

For some years the Caledonian went gently, while a crowd of little lines were preparing for absorption, some of them undergoing an intermediate amalgamation like the Scottish Midland, which in 1856, taking over the Newtyle & Coupar-Angus, the Newtyle & Glamis, the Arbroath & Forfar, and the Aberdeen, became the Scottish North Eastern. At length the Caledonian woke up, and in the three "amalgamation years" more than doubled its mileage. In the first of these, 1865, it took over the Scottish Central, which had absorbed the Dundee & Perth in 1863, which in its turn had absorbed the old Dundee & Newtyle in 1846; and, by means of the General Terminus, obtained access from the Pollok & Govan to the River Clyde. Next year the Scottish North Eastern came into the net, with a few smaller lines; and in the third of these years of extensions, 1867, wishing to have a proper port of its own, and fixing upon Grangemouth, it had to purchase the Forth & Clyde canal, including the Monkland, a canal of some interest, as by its purchase the Caledonian can claim James Watt as one of its originators.

Watt was the consulting engineer of the Carron Ironworks, his first partner in the steam-engine being Dr. John Roebuck, the Birmingham man, or rather the man from Sheffield, who established them. At the time he was engaged in surveying work yielding moderate returns. The very year, 1769, that he took out his patent for the steam-engine he was asked to survey a route for the projected canal, and it was on his survey that the Act was obtained "for making and maintaining a navigable cut or canal and wagon-way from the coalleries in the parishes of Old and New Monkland to the city of Glasgow." He was the first engineer, but want of means put a stop to the works in 1772, the year that Roebuck failed, and in 1775 he went to Birmingham and became the partner of Matthew Boulton. In 1789 the £100 shares in the unfinished canal were bought by the Stirlings at £5 apiece, and it was extended to Port Dundas to join the Glasgow branch of the Forth & Clyde, which afterwards bought the shares at £400 each, and in 1867 became absorbed by the Caledonian Railway Company.

Nowadays the Caledonian extends from Carlisle to Aberdeen on the east coast, and to Oban and Ballachulish on the west; but Carlisle is not its most southerly station,



LOCOMOTIVE BOILERS AT ST. ROLLOX WORKS, SHOWING HOW THE FLUE TUBES ARE PLACED for, by means of the branch from Kirtlebridge and through Abbey Junction, it reaches Brayton. At Lockerbie there is a branch to Dumfries, taken over in 1865, whence by the Kirkcudbright section of the Glasgow & South Western it obtains access at Castle Douglas to the Portpatrick & Wigtownshire.

This curious line is of single track throughout ; it is 82 miles long, and its importance consists in its affording, from Stranraer to Larne, the shortest route to Ireland, the distance being only 39 miles, in traversing which the boats spend but little over an hour on the open sea. It runs through Galloway and Wigtownshire, with a southerly branch to Wigtown and Whithorn from Newton-Stewart and a junction with the Glasgow & South Western at Challoch, and is a joint affair belonging to the Caledonian, the London & North Western, the Midland, and the Glasgow & South Western, the two Scottish companies controlling and working it by turns. Every three years the control of the engines, stores, telegraphs, and permanent way of the whole line is similarly changed about, and the road

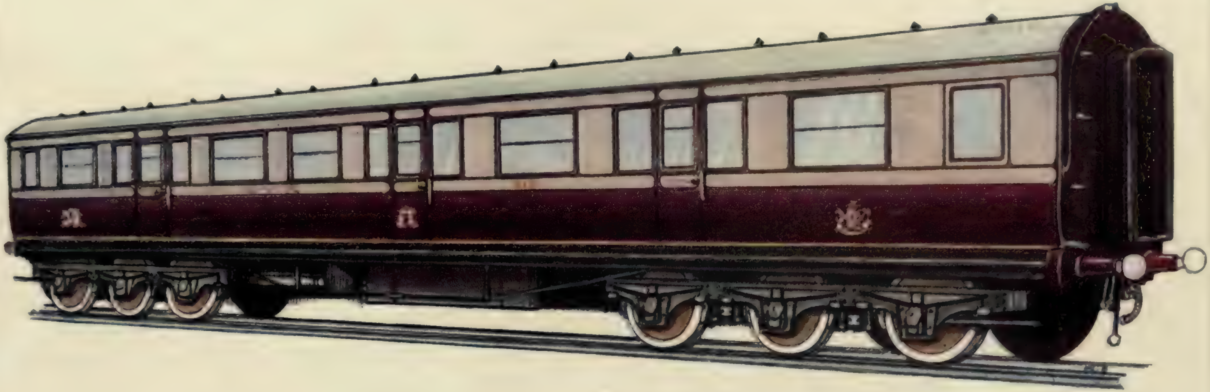
The Glasgow Express leaving Princes Street Station, Edinburgh.

requires some looking after, for it rises to a summit level of 800 ft. and amongst its many stiff gradients has three miles of 1 in 57.

At Elvanfoot, on the Caledonian main line, a branch goes off to Wanlockhead among the lead mines, where William Symington was born, and at Symington one to Peebles on the Tweed ; and then Carstairs is reached, which was the company's first junction and the starting-point of the engineering work. To begin at Carlisle would never have done, as it would have recalled the English origin of the enterprise which had been so excellently hidden in its name ; Glasgow was hostile, and was reached on an existing line, and Edinburgh could not be chosen without giving further offence. Carstairs was neutral and really convenient, and here the first sod was cut, or rather three sods : one towards Glasgow, one towards Edinburgh, and one towards Carlisle, so as to be quite impartial. From Carstairs the road to Edinburgh continues to the right while that to Glasgow trends to the left ; and then the network begins that ends on the west coast at Ardrossan and Wemyss Bay, and stretches eastwards to Midcalder and northwards to Dunblane, where the western road goes off to Loch Tay and the Firth of Lorne, and the eastern to Perth and onwards to Aberdeen.

Altogether the Caledonian is nearly 1100 miles in length, and has about fifty terminal stations. In a year it carries 34 millions of passengers, 23 million tons of minerals, and over 5 million tons of merchandise ; and it owns some 65,000 vehicles and 927 engines. On its main track the Beattock bank ensured its having powerful engines from the first, though on the local lines it annexed were a few miscellaneous antiquities that need not here detain us.

For opening the line Robert Sinclair, afterwards of the Eastern Counties, designed some 2–2–2's, of which the leading and trailing wheels were 3 ft. 6 in. and the drivers 6 ft. ; the cylinders, 15 in. by 20 in., were outside



THE CALEDONIAN RAILWAY

Composite Corridor Carriage, No. 217

Extreme length . 68′ 6″
Extreme width . 9′ 0″
Height from rail . 12′ 3″
Wheel base . 56′ 0″
Total weight . . 38 tons 4 cwt.
Stone's system of electric lighting.
Compartments { First-class . 5. Third ,, . 3.
Seating capacity { First-class . 30. Third ,, . 24.
Heated by steam storage system.
Westinghouse quick-acting brakes.
Two lavatories.

and inclined, the heating surface was 770, and the grate area 10½. They worked at a pressure of 90 lb., and with the 4-wheeled tender, that held 800 gallons, weighed 28 tons. The springs were peculiar; for the driving and leading wheels they were underhung, but those of the trailers were elliptic and controlled by a screw arrangement on the footplate which lifted the weight off them and transferred it to the drivers. These he followed by a more powerful class with 7 ft. driving wheels and 16 in. by 20 in. cylinders.

Engine-building at St. Rollox.

In 1856 he resigned, and was succeeded by Benjamin Conner, who held the position for twenty years. Conner began with some excellent and quite famous singles with 8 ft. 2 in. drivers, and cylinders 17 in. by 24 in., the heating surface being 1172 and the grate area 13·9. The weight of these engines in working order was 30 tons 13 cwt., and the tractive force was 4700 lb. As Mr. M'Intosh says, "this stately engine, with its monstrous and steady stride, was long the admiration of the whole country," and Colburn years ago described it as "standing gracefully on its wheels, large yet compact, and qualified to run at any speed with ease and steadiness."

Like Stirling's 8-footers, the only engines to which they came second in appearance and efficiency, the class had a long career, but the increase of the train load became too much for them, particularly up Beattock bank, and when in 1882 Mr. Dugald Drummond, better known, perhaps, as of the London & South Western, took over from Conner's successor, George Brittain, he had to supersede them by engines of greater power. During the race to Edinburgh his No. 123 was a 4–2–2 with 7 ft. drivers, the cylinders being 18 in. by 26 in., the working pressure 150, and the weight of engine and tender 75 tons 7 cwt., but most of his engines were 4–4–0's. As an example may be mentioned the Eglinton, which was put on the rails in 1887; this had 18 in. by 26 in. cylinders, 6½ ft. driving wheels, a heating surface of 1200, and a grate area of 19·5, the pressure being 160 and the tractive force 12,900. Mr. Lambie, who succeeded him, was responsible for only six express engines, the excellent class Nos. 13–18.

In 1895 Mr. John Farquharson M'Intosh became locomotive superintendent, and soon his Dunalastairs led the way. The second Dunalastairs were 4–4–0's with 19 in. by 26 in. cylinders and 6½ ft. drivers; they had a heating surface of 1500, a grate area of 20¾, a pressure of 175 and a tractive force of 16,840; and with tender complete they weighed 94 tons. With the Dunalastair classes the reputation of the Caledonian engines was greatly enhanced.

A remarkable experiment was made with fourteen of them on the 7th of September 1899 at an excursion of the people at the company's locomotive works at St. Rollox. These 15,000 excursionists were carried in fourteen trains each of eighteen coaches all alike, and each engine was an improved Dunalastair. The first train started for Carlisle from Glasgow at ten minutes after five, the others leaving at ten minute intervals, except the last two which were twenty minutes apart. They were timed to reach Carlisle in 2 hours and 25 minutes, the return journey to take 2½ hours; and with each train out and home the time was kept to the minute. Each engine consumed 1 ton 12 cwt. of coal on the journey, or 35 lb. per mile; that is to say it took 3 lb. 4 oz. of coal to carry each passenger from Glasgow to Carlisle. Think what a wonderful thing is a locomotive that will so use the force obtained from 3¼ lb. of coal as to drag a man over a hundred miles in two hours and a half.

Carriage-building, St. Rollox Works.

And be it remembered that the road is far from a level one. From Carlisle it falls gently for about 7 miles to nearly sea-level, then rises for 7 at 1 in 200, falls gently for 4, rises for a similar distance at 1 in 200 past Ecclefechan, falls for 7 past Lockerbie, and rises for 7 to just past Wamphray. Then it rises for 4 miles at 1 in 200 through Beattock, and from this ascending slope it climbs at 1 in 75 and 1 in 80 to Beattock summit, 1014 ft. above the sea. From the summit it descends with slight undulations through Abington and Symington for over 20 miles to Carstairs, and from there it follows the Clyde down to Glasgow. A rising gradient of 1 in 112 trebles an engine's work; one of 1 in 75 quadruples it; thus an engine requires four times the power to climb to the summit level that it does from there onwards.

The second Dunalastairs were a good class for comparison. Their cylinders being 19 by 26, the cylinder volume was 14,742 cubic in., and as their heating surface was 1500 it follows that the amount of cylinder volume for every square foot of heating surface was 9·82 cubic inches. In the Cardean, which came later, the heating surface is 2460, and consequently the volume per square foot is only 6·6 cub. in., the cylinders being 20 in. by 26 in., and their volume 16,342·86. The engines of this 903 class are 4–6–0's with 6½ ft. drivers, their grate area is 26 and their working pressure is 200 lb. In running order the engine weighs 73 tons, and the 5000-gallon tender 57 tons, the combined weight being 130; and the tractive force is 21,333 lb. The length over buffers of these engines and their tenders is 65½ ft. Thus in the sixty years the length of engine and tender increased by 30 ft., the weight by 102 tons, the boiler pressure by 110 lb., the heating surface by 1630 sq. in., and the tractive force from 2344 to 21,333.

The nature of the track had also its beneficent influence on the goods engines, which from the beginning have been workmanlike and powerful, though the engineers of sixty years since would be surprised to find their old 6-wheelers developed into, say, the 600 class with 21 in. by 26 in. cylinders and 8-coupled $4\frac{1}{2}$ ft. wheels, or the 918 class with 19 in. by 26 in. cylinders and 6-coupled 5 ft. wheels, or even the 812 class with cylinders half an inch smaller. What they would have said to the 492 class of 8-coupled tanks—$4\frac{1}{2}$ ft. wheels and 19 by 26 cylinders—with a load behind them, is a mystery, but may be imagined from Sinclair being satisfied with hauling 50 tons.

Machine Shop, St. Rollox.

In his day the goods wagons were 11 ft. long and held 6 tons, now by gradual increase they have arrived at 66 ft. in some cases, and hold 30 tons. So long ago as 1858 the Caledonian put a 30-ton wagon on the line, and now they are in hundreds; and for miscellaneous goods the packing of these monster trucks is a wonder. Then there was but one pattern of wagon, and everything had to be got into it somehow; now there are special wagons and vans for all sorts of things—milk, fish, beer, furniture, scenery, horses, glass, minerals, armour-plates, and steel castings, the coal and iron districts of Lanarkshire and Stirlingshire being the main source of the company's prosperity.

When the goods station opened at St. Rollox the first day's business amounted to the reception of three carts, the first of which brought one package, the next a cask of whisky, the third four small parcels ; now 50,000 packages come to Buchanan Street in a day, and it is only one of the eleven terminal goods stations in Glasgow belonging to the Caledonian. Five million tons of miscellaneous goods in detail require some handling ; and in the bulk, when added to 23 million tons of minerals, the wagons require some sorting, even on the best hump and gridiron system, as is evident any day at Ross or Robroyston.

The Caledonian crossed the Clyde into Glasgow from the south in 1879 and opened the Central Station, which twenty years afterwards had become too small and had to be enlarged, the extension necessitating another bridge across the river as well as one over Argyle Street. With the hotel it forms an imposing block of buildings, and no one who knows it would suggest a better name. It has a train in or out of it every two minutes during most of the day ; the circulating area is about an acre, and there are thirteen platforms, totalling up to nearly 2 miles in length, the space and accommodation being none too large for the crowds that swarm in and out. Let it be enough to say that it is the Liverpool Street of Glasgow.

About 480 miles of the Caledonian are single track. When railways began in this country a man used to ride on the engine from one station to another and return by the next train ; and, as he could not be in more places than one at the same time, safety was assured. In case of accident the old system is still in use. When worked as a single line on emergencies a pilotman, distinguished by his wearing a red armlet, accompanies every train unless more are going in the same direction, when he travels on the last engine. But for everyday working it was discovered in 1853 that the man could be dispensed with if he left his badge of office behind him. Hence for a long time a short stick like a constable's truncheon, bearing the names of the two stations between which it could be used, was handed to the driver of the down train and brought back by the driver of the next up train, and this truncheon eventually gave place to a brass casting still called the train staff.

No improvement was needed on this method so long as the trains ran alternately to and fro, but when there were more trains in one direction than in the other there was no way of getting the staff back except by sending the first trains of the batch without the staff but with instructions what to do. Here was an opening for an inventor, and in 1860 the Board of Trade authorised the introduction of the Woodhouse method, which had been adopted for the working of the Standedge tunnel.

This was simple enough. The staff brought by the last train to arrive was shown by the stationmaster to the engine-driver of the next train in the opposite direction, so as to satisfy him that he could not meet a train on the way, and the driver was given a ticket allowing him to run to the station from which the train had come. Train after train could be despatched in this way, each with a ticket, except the last, which carried the staff for it to be in readiness at the other end to be returned in a similar manner. The tickets were collected at the other station on arrival, and kept in a locked box which could only be unlocked by the staff used as a key, and on being taken out they were used again for the trains going back, in which they preceded the staff in the same order. In fact, the staff and tickets were like hen and chickens, the chickens leading the way and the hen following. It was soon found, however, that once the tickets were loose an unlucky one could be given away when the staff was not at the station, and so the tickets came to be made of brass and locked into a hole in the staff, so that they could not be got at unless the staff was at the station they were taken from.

Here again there was no provision for emergencies, and none for the staff reaching a station the last thing at night when a train had to leave the other station first thing next morning. In Wales this had been met by sending the staff by horseback over the mountains, but this did not commend itself generally, and was only possible in the event of the terminals of the line being close together.

The problem was solved by the invention of the tablet system by one of the Caledonian men. In this a box at each station represents the staff, the boxes are in electric connection, in them are so many quoit-shaped tablets which can only be removed one at a time, and then only when the electric circuit is completed by the signalman at the other station. The tablet is taken on by the train to the signalman who has unlocked the box, and not until it has been put into the box at his end can he render another tablet available at the far end. Thus the train is always under the control of the farther signalman.

On the North Western a method much of this character came into use in which there were no tablets but a number of brass sticks all alike, and made so that they could open any of the intermediate sidings within the section; and there are other devices, including that on the Great Western —a modification of the Manson system—where the staff is like a tennis-racket, and set on a post near a station so that it can be hooked off by the engineman's arm while passing it at speed, to be parted with at speed by being thrown into a net at the end of a section, when the next racket is borne off as in tilting at the ring should the train not stop at the station. But the essential feature of all the systems is that no one thing, staff, tablet, or what not, can be in two places at once.

Along the Caledonian runs our principal mail train—

"the postal train for mails and parcels post" that gives an arterial service through Great Britain from London to the northern terminus of the Caledonian, the joint station at Aberdeen.

"The vehicles appointed to work this new postal train," says Mr. Neele, "were all constructed with connecting covered gangways, so that the Post Office people in charge could pass from vehicle to vehicle throughout the train, and the gangways and doorways were all sufficiently commodious to allow of the transfer of parcel post receptacles when necessary to get them in position at the respective exchange stations. The sorting carriages were all brilliantly lighted, and it was a sight that must have gratified Mr. Baines"—the representative from St. Martin's-le-Grand who had suggested and organised the scheme—"when the train, on the first night of its running, the 1st of July 1885, was placed in position at Euston for its maiden trip. No wonder the head officials of the Post Office clustered that night at Euston; it

The Caledonian Bridge over the Clyde at Glasgow.

was a notable event, the starting of this pioneer postal train."

It was a train to be remembered ; with it began the system of specials for mails only, now in vogue on so many lines ; and it has grown in importance and length until it measures 150 yards or more when it starts. Its marshalling is as would be expected. Next to the engine is the Aberdeen brake van with the through bags for Scotland that require no sorting, and in the rear are the English through bags ; the Scottish parcel and letter sorting vans and the English sorting vans being in the middle.

It is timed to start at half-past eight ; but for an hour or more before that the sorters are at work, amid an array of racks and pigeon-holes and hooks and bags to be seen nowhere else, shuffling, packing, stamping, gathering, and distributing the contents of the bags that red cart after red cart piles in, until the apparently never-ending procession is closed by the late-fee letters and the sacks that time at headquarters has forbidden any attempt to deal with.

Off it goes to the minute. In the sorting vans is the apparatus by which the bags in pouches are received and delivered as it runs, consisting of an arm and a net, the net above, the arm below. At the different places along the line where the train does not stop is the corresponding apparatus with which it gives and takes ; this also consisting of an arm and a net, the net being below ; and on its journey it will catch and deliver at about five dozen of these, for every one of which the pouch must be ready.

Out go the pouch or pouches on the delivering arm to be caught and the net to catch with ; the electric bell starts ringing ; clack cluck, the ringing stops, and at the same instant the pouches on the train have gone and the pouch from the roadside arm bounds on to the floor as if it had been shot in from a gun, and sometimes as from a battery, when, as at Bletchley, many come bumping in.

Quickly, as if it were an enemy's explosive, the pouch is opened and cleared out, and up and down the van its contents fly on to the tables and into the pigeon-holes, while out of the pigeon-holes come other packets to be thrown into bags to be thrust into pouches to be hung on the arm and start the bell ringing again. Sort, sort, in the glaring light as the floor thrills and heaves on the springs, hurrying furiously at first and then slowing until the train stops at Crewe or elsewhere, when the haste begins again, the pressure at every stoppage being less and less, as well it might be. As with the letters so with the parcels, heavier work meaning more noise but easily conceivable, the only difference in method being that every parcel has to be called.

A Spring Holiday Crowd at Glasgow Central Station.

Rugby, Tamworth, Crewe, Wigan, Preston, Carnforth, Carlisle, those are the English stopping stations. At Preston the Liverpool van is left and a pilot engine goes on to help in the heavy pull from Carnforth up to Shap (914 ft.) and join in the downward swoop to Carlisle.

Here in the early morning—2.48 a.m.—the London men leave the train. The Scottish sorters take their places, and the one Caledonian engine takes the place of the two North Westerns. The train is now much lighter and it becomes lighter still, for the Galloway van goes off to Stranraer and the Ayr van departs for the Glasgow & South Western. Up to Carlisle the date is the date of departure, north of it the date is that of arrival, and the lettering becomes "Caledonian T.P.O. Night Down."

In a minute or so the mail is travelling to the Solway as if St. Rollox had pitted itself against Crewe in emulation of the wild career from Shap ; and the seven miles down leads to the seven miles up, and makes no more difference than the four up and the four down or the following seven up and seven down, for the engine is in full swing for the gentle rise through Beattock from which it makes its effort up the hill, slowing perforce as the ten-mile climb nears its end, and quickening as down it runs through Abington and Symington to Carstairs. Here the train loses the Glasgow and Edinburgh vans, and the lighter it gets the faster it goes.

At Stirling some coaches from Edinburgh and Glasgow are hooked on, and the western mail packages are left behind ; and thence for over thirty miles it sweeps, rushing through Crieff and Auchterarder, reeling off mile after mile at from 55 to 60 seconds each, to stop at Perth at seven minutes before six. Here the engine is changed, and before the clock strikes the hour the mail is on the way again for its flight to Aberdeen, just ninety miles in ninety-seven minutes.

The five hundred and forty miles are completed at last. It is no exceptional run, but the regular task of every week-day. And no better work is done in van or on engine than between London and Aberdeen by the special postal trains.

The passenger work of the Caledonian is of high repute for speed and accommodation. As we have said enough of the West Coast service we will content ourselves here with the Grampian Corridor Express as an example. This train is made up of four varieties of coaches, composite, brake composite, brake third, and third. Each of these is 65 ft. long in the body, and 68 ft. 6 in. over buffers, the width being 9 ft. The under-frames over headstocks are 64 ft. 10 in., 44 ft. between the bogie centres, and 7 ft. 5 in. over the sole bars, the wheel base being 56 ft.

Wemyss Bay Station.

In the composite the space between the partitions is 7 ft. 4⅝ in. in the first class, and 6 ft. 4½ in. in the third; in the brake composite it is 7 ft. in the first class and 6 ft. in the third, the brake compartment taking up 12 ft. 2¾ in.

In the brake third, in which the brake compartment occupies 27 ft. 4½ in., it is 6 ft., and in the third it is 6 ft. 2⅝ in. The composite seats 30 first-class passengers three aside and 24 third class four aside, the brake composite seats 18 first and 32 third, the brake third seats 40, and the third 72. The composite weighs 38 tons 4 cwt., the brake composite weighs 38 tons 11 cwt., the brake third weighs 35 tons 5 cwt., and the third 36 tons 10 cwt. These details are given to show, among other things, that appearances may be deceptive; in carriages seemingly alike there may be a difference in the knee-space making all the difference in the comfort, though in this case the smallest, 6 ft., is ample for any one of reasonable stature and attitude.

This heavy train—the Grampian—does 30 miles an hour up Dunblane bank, part of which is 1 in 73, for Beattock is not the stiffest gradient on the line, that being the 1 in 40 on the Bonnybridge branch. It is the 10 a.m. out of Buchanan Street and the 9.30 out of Edinburgh joining at Perth, where the restaurant car is put on; and the Glasgow portion weighs over 250 tons. It is not the fastest on the line, that being the 10.5 from Forfar to Perth, 32½ miles in 33 minutes, the longest non-stop being the 2.17 a.m. from Carlisle to Perth, 150¾ miles in three hours; but with the exception of the Granite City Express, leaving Glasgow at 5 p.m., it is perhaps the best known.

At the other end of the varied list of passenger rolling stock is the vehicle working the local traffic over Connel Bridge, a notable cantilever structure with a span of 500 ft. across Loch Etive between Connel Ferry and Benderloch, which not only runs frequently on weekdays but makes trips out and home on Sundays—a motor-car that hauls trucks on which are placed the motor-cars in which the owners ride as owners used to ride in their own carriages on the railways in the old times.

There are other bridges besides Connel that should be mentioned. Among them are the handsome bridge that crosses the Clyde at Glasgow, the Tay bridge at Perth, the Dee bridge at Aberdeen, and the two Forth bridges—that at Stirling and the swing bridge at Alloa. It was at South Alloa in 1865 that the Caledonian became possessed of its first harbour, the one there being taken over with the Scottish Central. It served as an appetiser and stimulant for the greater venture of 1867, when the purchase was effected of the Forth & Clyde canal, with Bowling harbour at one end and Grangemouth at the other, where the *Charlotte Dundas* lies buried.

Wemyss Bay—off for a trip down the Coast.

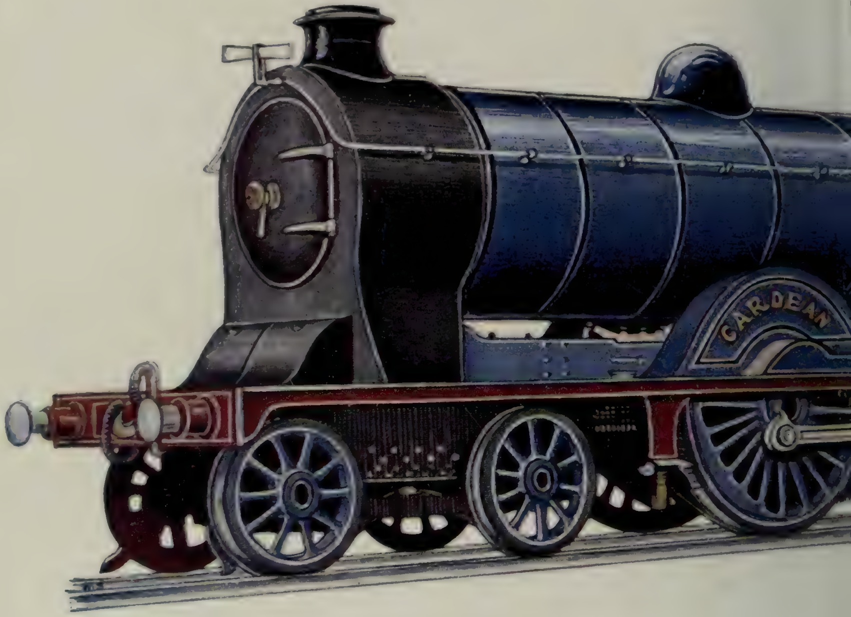
Every one knows that in March 1802 William Symington's *Charlotte Dundas* began work on the Forth & Clyde canal, but it is not always added that Symington had a steamboat on the canal before her in 1789 at the expense of Patrick Miller of Dalswinton, which was the successor of another boat tried elsewhere the year before. Miller was Robert Burns's landlord. He was a director of the Bank of Scotland, and a man of ingenuity interested in many things, among others Clerk of Eldin's idea of breaking the line which Rodney had found so satisfactory in 1780. "Why not have a ship," thought Miller, "that can break the line in all weathers and all conditions of the sea?" That was the germ of all that followed; another instance of how the paths of war lead to the triumphs of industry.

Knowing Alexander Nasmyth, the father of the inventor of the steam-hammer, a draughtsman and artist of great ability, he proceeded with his assistance to get out the working drawings of a catamaran with two hulls having paddles between them, the paddles being worked by a five-barred capstan. This was tried on the Firth of Forth on the 2nd of June 1787. The men ran and ran, and slowly moved the catamaran. "I'll tell ye what, Dalswinton," said James Taylor, then student of theology and tutor to Miller's sons and on board as a passenger, "ye might save the puir bodies if ye wad only use the new steaming engine!"

The very thing, thought Miller. Back to the wharf came the catamaran. The new engine was the one patented three days afterwards by Taylor's friend, William Symington of Wanlockhead, then aged twenty-four.

In 1786, the same year that Wilson reported to Soho that Murdock had made a model road locomotive, Symington and his brother had made "a model steam road-carriage," which they were exhibiting in Edinburgh, and it was on reading the newspaper notices of this that Murdock had started on his journey from Redruth to London, so as to be first at the Patent Office. He need have been in no hurry, for the road-carriage was never patented and went no further. What Symington patented on the 5th of June 1787 (No. 1610) was a stationary engine—the drawing showing an engine-house complete—which was to develop in quite another direction.

Taylor introduced Miller to Symington, and a conversa-

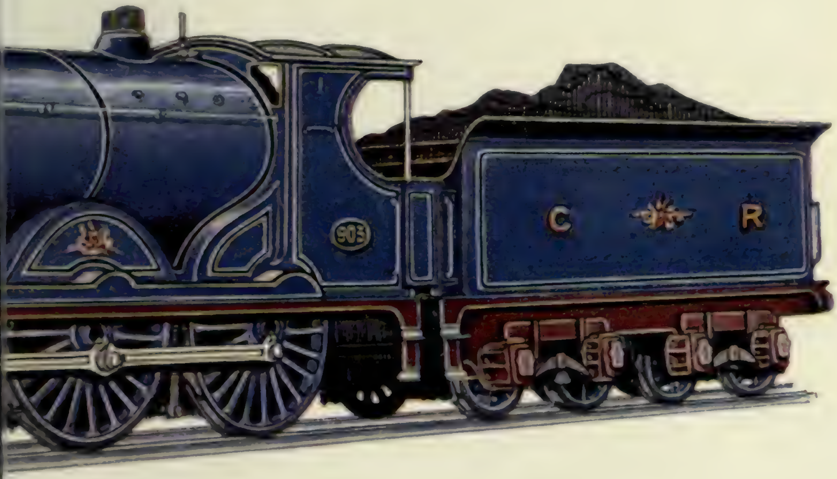


THE CALEDO

EXPRESS PASSENGER

DESIGNED BY MR. JOHN

BOILER	Length	17′ 7⅞″	**FIRE BOX**	Length	8′ 6″
	Diameter	5′ 3½″		Width	4′ 0″
CYLINDERS	Diameter	20″			
	Stroke	26″	**HEATING SURFACE**	Tubes	2311·75 sq. ft.
				Fire box	148·25 ,,
TUBES	No.	242			



AN RAILWAY

OCOMOTIVE, No. 903

McIntosh, M.Inst.C.E.

Diameter of Wheels	Bogie	3′ 6″
	Coupled	6′ 6″

Grate Area . . . . . . 26 sq. ft.

Working Pressure 200 lb. per sq. inch.

		Tons.	Cwt.
Weight in Working Order	Engine	73	0
	Tender	57	0
	Total . . Tons	130	0

Water Capacity . . . 5000 galls.

Coal Capacity . . . . . 6 tons.

tion followed which ended in his agreeing to place one of these engines duly adapted on board one of Miller's boats, just as Jonathan Hulls had tried to do with an engine of Newcomen's in 1736 (Patent No. 556), and succeeded in doing on the Avon at Evesham in 1737. Thus it came about that on the 14th of October 1788 there came forth on Dalswinton lake this noteworthy steamboat, the engine of which is at South Kensington (N. 5). She was built of tinned iron plates, and was a double-hulled catamaran with the paddle-wheel in the middle, and she moved at the rate of four or five miles an hour. On board — according to James Nasmyth—were Miller, Nasmyth, Taylor, Sir William Monteith, Symington, and Robert Burns.

Among the letters not long ago discovered at Soho is one from Cullen on behalf of Miller asking for estimates regarding a Watt engine to take the place of Symington's, to which the firm replied charging Symington with attempting to evade their patent. This may have stopped Miller from going further with Boulton & Watt, for he continued to employ Symington, and used one of his engines in the boat on the Thames running between Blackfriars and Westminster in 1793, mentioned by Carlyle, which was followed by the immediate predecessor of the *Charlotte Dundas*.

The *Charlotte Dundas* led on to Fulton's *Clermont*, Bell's *Comet*, and many other developments. Greenock became a steamer port, and to it in 1841 there opened the Glasgow, Paisley, & Greenock Railway which was absorbed by the Caledonian. Then the Glasgow & South Western ran in from the south through the tunnel down to the river, and got into communication with what are known as the coast steamers. In 1866 the Caledonian, intending to extend to Gourock, purchased that harbour, but had to abandon the proposed railway to it owing to the financial panic; and it was not until 1884 that they obtained the Act which gave them the needful access by the line through the tunnel, 2100 yards in length, which is the longest but one in Scotland, the longest being that of 2519 on the North British at Glenfarg. From the Greenock line at Port Glasgow they went on to Wemyss Bay, to pick up more of the profitable coast business which, as far as the steamers are concerned, is now pooled among the rival Scottish lines.

Of these boats the Caledonian own nine ; the Glasgow & South Western own nine ; and the North British have seven ; and to these must be added the boats of the private owners. They are the famous Clyde river steamers, than which there are none better ; not the launches plying in the city waters, which, be it understood, are quite another sort of craft.

The Clyde steamer, when she starts, with her spotless paint, white decks, and silver-plated gear, is almost as trim as a man-o'-war, and handsomer. Her handling is excellent ; her departure and coming alongside to the very inch of her berth without the suspicion of a see-saw is the perfection of seamanship ; and the wonderful number of places she seems to go to, as shown by the pigmy semaphores, is quite a lesson in the geography of the west.

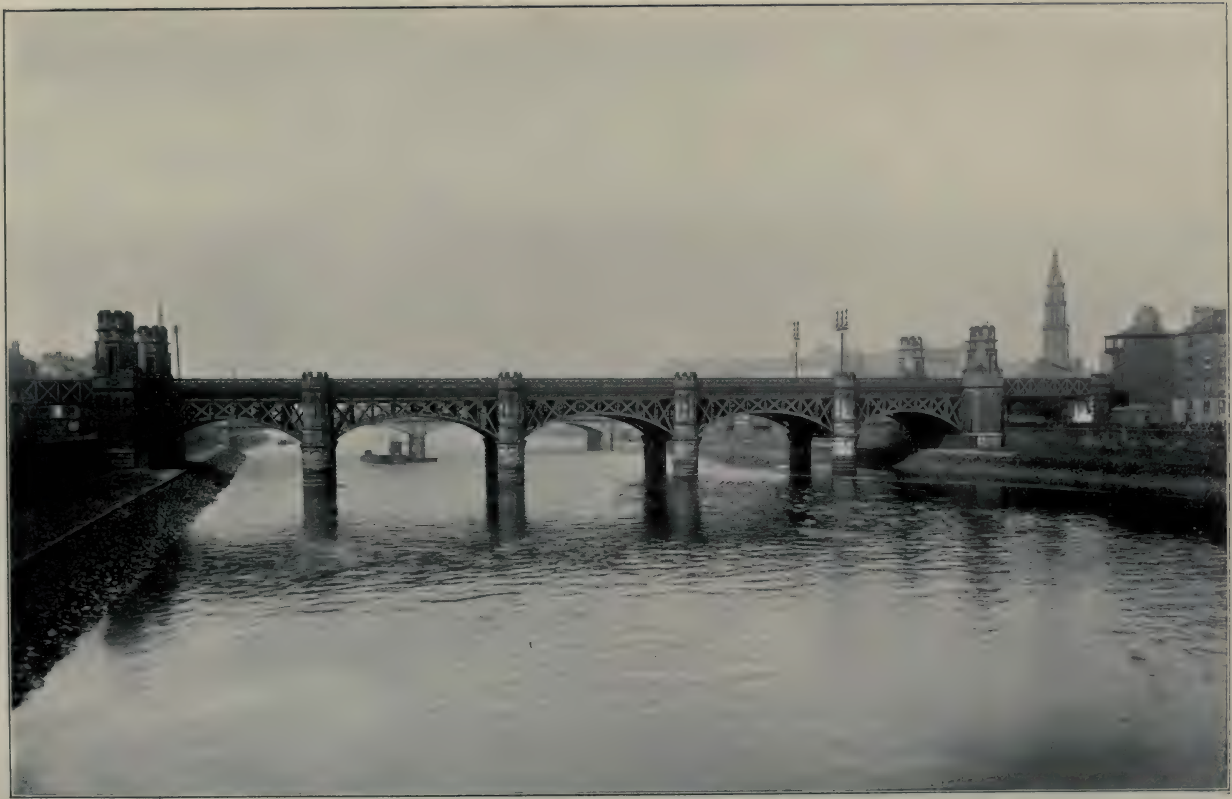
At first the packet companies had things all their own way in taking the people down the river from Glasgow Bridge, but things have altered, and the Broomielaw before breakfast is not what it was. The old Glasgow, Paisley, & Greenock began the new era by putting on the water the *Isle of Bute* and the *Maid of Bute*, plying from Greenock. Two more boats followed, and in 1852 the Caledonian built the first of its own, the *Greenock* and the *Glasgow Citizen*, but it was not for another fifteen years or so that there began that combination of rail routes with steamer routes which has developed so surprisingly.

The Clyde is a curious river, practically a narrow canal with vast stretches of mud on either side at low water, and at high water assuming the appearance of a wide estuary. Unlike the Thames, which ends among flats, the Clyde ends among mountains and lakes, and it is worse near the city than the London river; but, as on the Thames, the all-river route went out of fashion owing to the increasingly unpleasant state of the water to begin with; then the evidences of industrial enterprise that appeared too prominently on the banks; and then the competition of the railway companies with their cheaper fares,—in short, the journey was odoriferous at the start and tedious in the continuation, and the railways improved the opportunity.

Balloch Pier—Loch Lomond Steamer *Prince George*.

It was in 1889, when the line opened to Gourock, that a serious fight was deliberately entered upon. The Caledonian ordered a fleet of the finest passenger boats, the first of which, the *Galatea* and *Caledonia*, came on the river on the 1st of June 1890, and, working them in connection with the railway, soon secured the greater part of the passenger traffic with the seaside resorts round the mouth of the Clyde. The completion of the Lanarkshire & Ayrshire gave the Caledonian access to Ardrossan, and for the voyage thence to Arran there was built the famous *Duchess of Hamilton*, on which a turbine was first used for electrical purposes. For a long time, with her 18 knots, she was the pride of the fleet, a position now held by the *Duchess of Argyll*, which is not only lighted by turbine but driven by turbine at over 21. That these boats were and are worked with energy is clear from the Caledonian fleet running more miles in a year than there are from here to the moon; and as the other railways on both sides of the stream joined in the fray as soon as they could, the non-railway shipowners had to come to terms, the result being the remarkable rail-and-boat system that carries all Glasgow to and from the coast in numbers and at fares that the rest of the world wonders at.

A Caledonian Steamer in the Firth of Clyde.



THE GLASGOW AND SOUTH WESTERN BRIDGE OVER THE CLYDE, AT GLASGOW

St. Enoch Station and Hotel, Glasgow.

THE GLASGOW & SOUTH WESTERN

THE Glasgow & South Western begins its pedigree with a colliery line, the Act being obtained in 1808 for connecting the Duke of Portland's collieries near Kilmarnock with the port of Troon. It was nine and a half miles long, and the company had a share capital of £55,000 with £10,500 in loans, or, as we should call them now, debentures. Opened in 1811, it was worked at first by horses, and it was the first passenger line, for on it was a passenger car very busy in the summer evenings and on holidays carrying to the "saut watter" and back the Kilmarnock weavers, who were in fact the first seaside trippers.

This line was made by William Jessop, and did not have tram-plates but his cast-iron edge rails on stone blocks. On it was placed the Killingworth engine with the chain gearing bought by the Duke of Portland from

George Stephenson in 1817. The iron wheels of this remarkable engine broke down the cast-iron rails, for it thumped horribly, but, instead of being withdrawn from duty, as usually reported, it had its iron wheels taken off and replaced by wooden ones; and with wooden wheels it worked the traffic—mineral, goods, and passenger—until 1848, for so many years in fact that it has been confused with or mistaken for the old St. Rollox, one of the first engines of the Glasgow & Garnkirk, which it in no way resembled.

Two years before the Kilmarnock & Troon obtained its Act—to be precise, on the 31st of July 1806—Hugh, Earl of Eglinton, who would lend a hand when his sword was wanted but was at a stand when there was aught to say, founded the harbour of Ardrossan to make it the port of Glasgow. There were then no steam tugs, and tedious and difficult was the navigation of the Clyde above the Cumbraes, while above Port Glasgow the river was so shallow in places and generally embarrassing as to be practically unnavigable except by small craft.

The scheme was a good one though it went awry. The harbour works were projected on a scale so grand for those days that in 1815 after the estimates had been exceeded they came to a standstill. Over £100,000 had been sunk in them, and Telford and Rennie wanted £300,000 more—a noteworthy instance of what the estimates of these great men were worth. In 1833 the abandoned works were taken in hand by the next Earl, Archibald of tournament fame, and he it was who completed them in a less ambitious manner.

To carry the goods to and from the new port of Glasgow there was projected at the same time the canal. This woke up the Clyde Trust, and was the real cause of their Act of 1809 giving them power to make the river at least nine feet deep at neap tides between Glasgow Bridge and Dumbarton. Further, on the 12th of January 1812

Henry Bell's *Comet* appeared on the Clyde to ply between Glasgow, Greenock, and Helensburgh, and the *Comet* was soon followed by the *Elizabeth*, and steam navigation had begun. This was a sore blow to the Ardrossan scheme, and when the harbour works stopped the canal stopped, so that it got no farther from Glasgow than Johnstone in the centre of Renfrewshire. It was this canal, known as the Glasgow, Paisley, & Johnstone, that endeavoured in 1830 to turn itself into a railway, and in 1883 succeeded in doing so by becoming part of the Glasgow & South Western.

Meanwhile in 1827 an Act was obtained for making the Ardrossan & Kilwinning, another colliery line on which, besides the coal wagons, ran a passenger van described in some quarters as a one-horse omnibus. Originally it was intended to run this line from the sea to join the canal, but it also stopped short ; and in 1837 came the Act for the Glasgow, Paisley, Kilmarnock, & Ayr, which picked up these two loose ends, the Troon and the Kilwinning, on its way to the south.

When the Kilwinning was projected certain influential people in Glasgow began to discuss a scheme for a railway to Paisley, and when in 1835 Joseph Locke's report in favour of a line up Nithsdale became public property, these cautious merchants answered with a plan for a route through Paisley down Nithsdale to Carlisle, as already referred to in the story of the Caledonian. Then followed the years of battle ending in the Paisley line going on as the Dumfries & Carlisle, to be opened throughout in October 1850 and become the Glasgow & South Western, whose first meeting was held in March 1851. But the line does not reach Carlisle ; it stops eight and a half miles short of it at Gretna, which, as might be supposed by those who have heard of Gretna Green marriages, is just over the Border on the west bank of the river Sark that hereabouts divides England from Scotland ; and it obtains access to Carlisle by means of its running powers over that short section of the Caledonian.

Carlisle Station, it may be noted, was originally built by the Caledonian and the Lancaster & Carlisle. In 1860 it consisted of a single platform for both up and down trains; now it is a joint station covering over seven acres, with seven platforms and fifteen roads occupied by no less than eight railway companies—the Caledonian, the Glasgow & South Western, the North British, the Portpatrick & Wigtownshire, the Maryport & Carlisle, the London & North Western, the Midland, and also the North Eastern, who are the representatives of the old Newcastle & Carlisle, whose station used to be at London Road.

At Dumfries the Glasgow & South Western sends off one branch that forms the junction with the Portpatrick & Wigtownshire to Castle-Douglas and Kirkcudbright, and another, of the light variety, up the Cairn valley to Moniaive. Over the Cumnocks it reaches its summit level of 616 ft., and soon afterwards it branches to the east to Muirkirk and to the west towards Ayr, from which by two routes it reaches Girvan and Dunragit. Skirting the coast northwards, it extends as far as Largs, and its Glasgow network takes it to Greenock. From Kilmarnock its main route is over the line it holds jointly with the Caledonian through Stewarton. In short, it is what it calls itself, and nothing more, the Glasgow & South Western Railway.

In length it is 467 miles; it carries over 15 million passengers a year, nearly 7 million tons of minerals, and over 1½ millions of miscellaneous goods; and it owns over 19,000 vehicles and about 400 engines, which taken together travel some 7¼ millions of miles, to say nothing of what is done by a few steam motors on the Catrine and Cairn Valley branches. Though much smaller than either the Caledonian or the North British, it is quite as well managed; and it has two of the best things in Glasgow, the St. Enoch Station and the St. Enoch Hotel. To Glasgow its main line is the northern portion of the Midland route. More than once in its history it has been on the verge of amalgamation; but that has not taken place yet, though there are some who see in the crimson colour of its coaches an indication of its future.

The old route to the south was fairly easy, but the new, which is ten miles shorter, would not have commended itself to Joseph Locke. This is very much of a joint affair, having been made by the engineers of the two companies in alternate sections. Leaving Glasgow it rises for 11 miles, four of which are at 1 in 80; then it is almost level for about 2 miles; and then for 11 miles it runs downhill, four of them being at 1 in 70, which is a steeper gradient than that at Beattock on the Caledonian. From Kilmarnock southwards the route is along the old track. For 21 miles it rises at 1 in 99, 1 in 200, 1 in 150 to New Cumnock, and from the summit it makes its way

The South Express in charge of No. 335.

downhill to Gretna, which is 106¾ miles from St. Enoch's, the whole distance to Carlisle being 115½.

Kilmarnock, where the Stewarton line goes off, is the second largest station, and the branches from it north and west interlace so freely that you can get there from Glasgow by ten different ways. One of the branches, by the bye, runs to Darvel and Strathaven on the Caledonian, the section from Darvel onwards being another joint production, and worked by the two companies alternately every six months.

The station being a high level one placed on an embankment and approached by a viaduct, nearly every one going north by the Midland route remembers Kilmarnock, which has been weaving bonnets ever since it originated the industry in the sixteenth century, and took on many other things, including carpets, for which perhaps it is better known, for here it was that Thomas Morton invented the three-ply loom and the more ingenious Brussels carpet machine that works five colours with four needles. Hither in 1856 were transferred the locomotive and wagon works of the railway from Glasgow to the site at Bonnyton Square, in the angle formed by the main line and the Troon branch, so as to leave no room for extension, the result being that the coaches and wagons have now gone to Barassie.

The Glasgow & South Western runs through the heart of the Burns country, and station after station bears some familiar name. Close to the tunnel at Mauchline, high up, is Mossgiel; and two miles south of Mauchline station the trains run over the noble viaduct of Ballochmyle, the most picturesque engineering feature of the line. With its graceful arch this makes a perfect picture, as it bridges the thickly wooded, precipitous chasm high above the river Ayr, which in winter flood still sweeps through the gorge as the lengthened, trembling sea that Burns described.

Another noteworthy feature is the Union Bridge, by which it crosses the Clyde at Glasgow, a substantial looking structure of five river spans of 75 ft., and two street spans of 65 ft., the cylindrical piers of which are of cast-iron filled with concrete, sunk to a depth of some 90 ft. below high water; the columns above low water being of brickwork, faced with ashlar and capped with embattled towers.

There was nothing very remarkable about the early engines, but when the Settle & Carlisle was completed and the Midland obtained its through route to Scotland, Mr. James Stirling, then at Kilmarnock, produced for the Glasgow run the type of engine he afterwards took with him to the South Eastern. These were 4-coupled 7-footers with 18 in. by 26 in. inside cylinders, the boiler being domeless, the dome having its work done by the internal perforated pipe, the duplex safety valve being at first fitted on top of the firebox. These engines were quite satisfactory until the increased weight of the trains and the greater speed required proved too much for them. He was succeeded by Mr. Hugh Smellie, who in his first design retained the 18 in. by 26 in. cylinders, but reduced the diameter of the driving wheels by three inches and substituted a pair of leaders for the bogie. In his next

Express Passenger Engine No. 384.

class he reduced his driving wheels to 6 ft., and abandoning his carriers returned to the bogie; his next step being a somewhat similar type with 6 ft. 9 in. wheels.

Mr. James Manson came from the Great North of Scotland as his successor, and, substituting a steam dome for the perforated pipe, evolved a new 6 ft. 9 in. class with 18¼ in. by 26 in. cylinders, giving them a longer boiler and much larger tenders. Good as these were they were not good enough for the increased power demanded, the next advance being the well-known lot with outside cylinders 20 in. by 26 in., a heating surface of 1852 and a boiler pressure of 180, which proved quite equal to the 300 or 400 tons which the load had become. These are the engines which in their black-and-white lined green livery look so well and work so well in front of the Midland-looking trains.

Down Platform, Kilmarnock Station.

In 1866 the company were about to amalgamate with the Caledonian, the object of the West Coast companies

BALLOCHMYLE VIADUCT

being to shut the door of Scotland against the Midland. Had that happened the Settle & Carlisle would have been made in vain, and to thwart it the Midland opened negotiations with the Glasgow & South Western which went so far that the terms were arranged for the absorption of the Scottish line. The Caledonian and North Western opposed the Bill of 1867 for "this longitudinal amalgamation that had none of the public disadvantages of parallel amalgamation" with every weapon they could lay their hands to, and though it passed the Commons it was thrown out by the Lords. And it was during these times that the Glasgow & South Western took on the Midland manner which, under the subsequent understanding, it retains.

Kilmarnock—looking south from No. 1 Platform.

Though independent, the two companies work together with excellent results, one of which is that the Glasgow & South Western handles its parcel business as well as, or better than, any other Scottish railway company; and that is saying much. The writer's first experience of the line was when one day in Glasgow he had occasion to send a heavy parcel of books to a suburb south of the Thames. Within a stone's-throw of where he was staying was a little stationer's shop with a notice announcing that parcels were received for the G. & S.W.R. He left the parcel there just before four o'clock in the afternoon, and returned to write a letter announcing that it was on the way. That parcel was duly delivered in London as addressed five minutes before the letter next morning, being the quickest thing in parcels work he had up to then met with.

Like the other Scottish companies, the South Western, as it is always called north of the Border, adopted the shop parcel system, which might well be introduced generally. At the railway station you buy a packet of labels at a penny each, the labels being perforated through the middle. You wander about through the town, any town, buying what takes your fancy, and at the shop you tear off half a label, which is stuck on to the parcel. There is nothing more to worry about. When you catch your train at the station you go to the cloak-room, and there you are handed all your parcels in exchange for the other halves of the labels. Think of it! No struggling about with brown-paper packages of all sizes, no cab, no parcel gone to the wrong room at the hotel; all you do is to tear a label in half, and the shop and railway people do the rest.

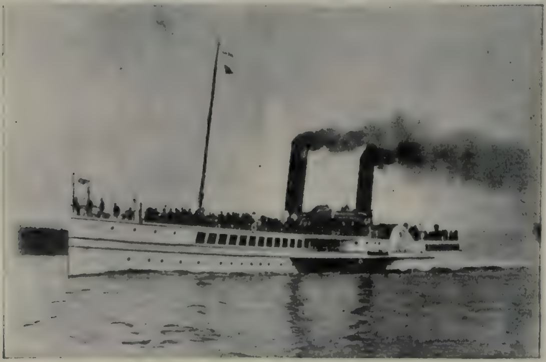
Its first Glasgow terminus was Bridge Street; then the line crossed the Clyde to Dunlop Street, and in 1876 it went a little bit farther on to the station named after St. Mungo's mother. How "S. Thennow, vidow mother of s. mungo vnder King Eugenius in scot. 445," whose day is the 18th of July and whose father was King Loth of Northumbria, in after days became, through error in transcription or difficulty in pronunciation, Thenaw,

Henaw, and eventually Enoch; and many other things, mostly unbelievable, about her, including the grand finale of her sinking boat being borne up the Firth of Forth on the backs of a shoal of fishes, is duly recorded in George Macgregor's *History of Glasgow* (one of the books that went in that parcel). What we are concerned with here is that one of the gates of old Glasgow was named after her, and just outside it was the little chapel which gave its name to the square where there is now one of the finest railway station fronts in existence.

Prince's Pier, Greenock.

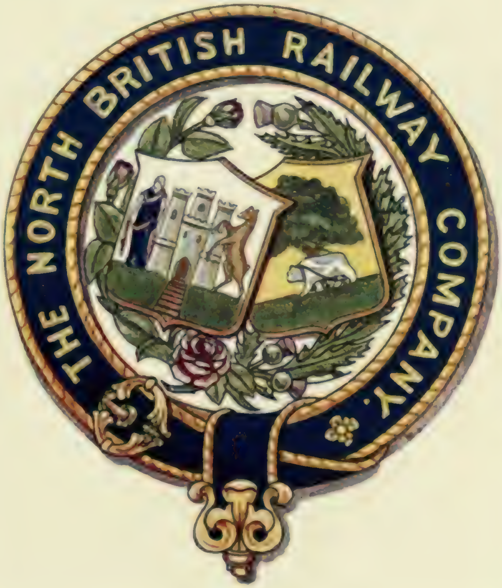
It is as distinctive as St. Pancras, and not unlike it in its high level approach. In style the hotel is described as Early English, not, however, so early as that of the days of King Loth; and it is really a fine, suitable building 240 ft. long and 130 ft. high. The best idea of its accommodation and equipment is obtained from the fact that the kitchen is 85 ft. long, 32 ft. wide, and 20 ft. from floor to ceiling. At first the hotel extended all along the front, where it may again go, but the station itself was not long since nearly doubled in width, and so overlaps it. There are now fourteen roads and twelve platforms, whose faces total up to nearly two miles; it covers 13½ acres, and each of the two spans, whose ribs weigh 54 tons each, is 205 ft. across. In some ways it had its influence on the design of the Brighton Company's new Victoria, the signalling being electric on the same system and there being a subway arrangement for parcels.

The Glasgow & South Western has its fleet like the Caledonian, and it is as numerous. It began with its steamers almost as soon; and it runs them, as it has done all along, from Greenock, though some of them work from Fairlie and Ardrossan. The *Juno*, *Jupiter*, and *Mercury* are as well known as MacBrayne's *Columba* and *Iona*, or the turbine-driven *King Edward* and *Queen Alexandra*, all of them worth going to Prince's Pier to look at; and round at Ardrossan is the *Glen Sannox*, a 19-knotter that carries you across to Arran so smoothly and quickly that you have hardly time to realise what a splendid vessel she is.



The *Glen Sannox* crossing to Brodick.

THE NORTH BRITISH


THE NORTH BRITISH RAILWAY COMPANY.

COAT-OF-ARMS

Waverley Station, Edinburgh.

THE NORTH BRITISH

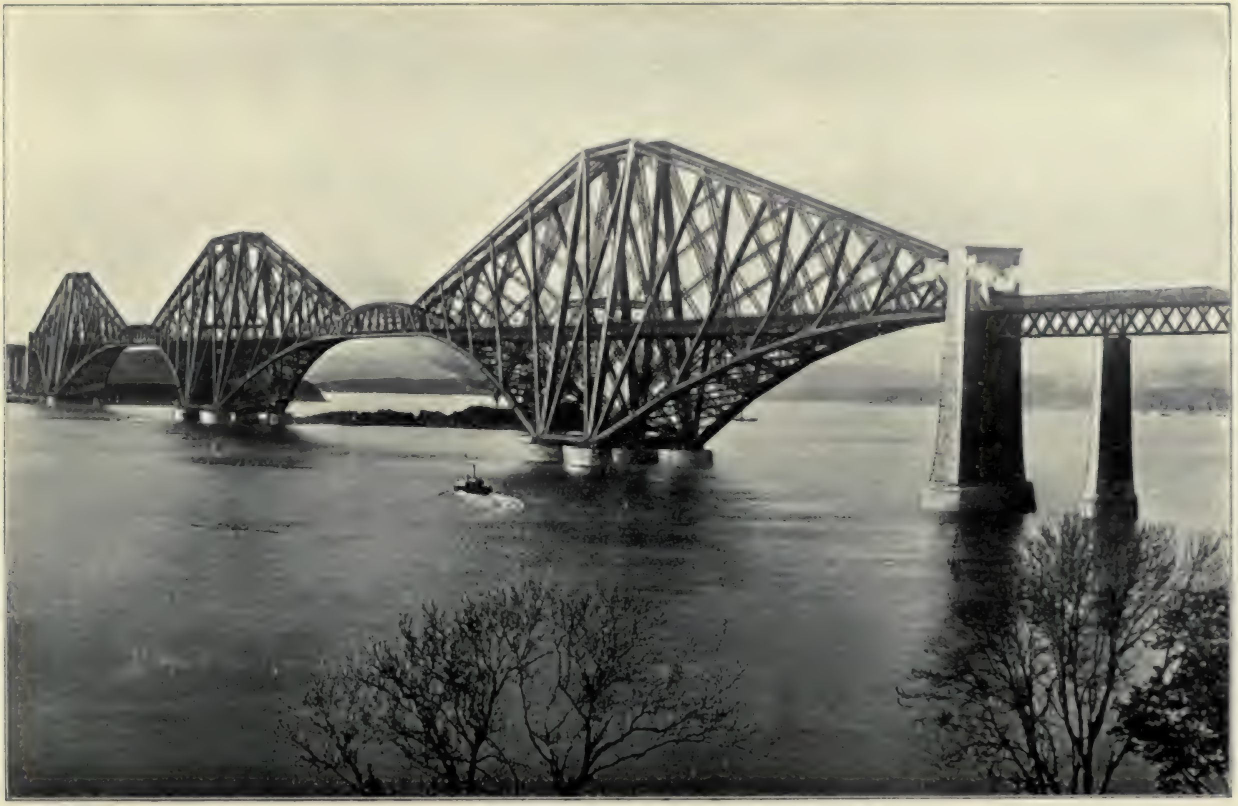
THE North British was the original name of the line which opened in 1846 from Edinburgh to Berwick ; but Berwick comes much earlier into railway history, for it was the intended terminus of the Glasgow & Berwick, surveyed by Telford and already referred to, which was projected by Martin Dalrymple of Fordel who died in 1809. Like the others, the North British, which is the longest railway in Scotland by some 350 miles, was built up by amalgamation, and the old companies it absorbed were unusually numerous.

The oldest railway, officially so called, now forming part of its system was the Monkland & Kirkintilloch, which in its Act of 1824 followed the example of the Oystermouth and Stockton & Darlington in obtaining powers to make and erect such and so many locomotive or movable engines as, in short, it pleased, and was likewise permitted to carry passengers. The line, at first single and soon doubled throughout, was opened in 1826, and ran for ten miles northward from the Monkland collieries and ironworks to the Kirkintilloch basin of the Forth & Clyde canal.

By it the coal and iron district of that busy part of Lanarkshire was put into more direct communication with the east coast than by canal. The railway was bitterly, and naturally, opposed by the canal people, but in vain, and with it began that strenuous competition, inadequately described as fights and battles, that has so pleasingly varied the story of railway enterprise north of the Border, the significant signs of which are the spacious legal offices of the two leading companies at Westminster.

The Far North Express crossing the Forth Bridge.

While the Monkland & Kirkintilloch was under construction by Thomas Grainger, who laid out several of the early Scottish lines, it was decided to extend it; and in May 1826, five months before it opened, an Act of Parliament authorised the Ballochney line joining it at Kippbyres and coming in from three branches. The Ballochney was



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THE FORTH BRIDGE

in time extended farther east by the Slamannan, and the three companies amalgamated as the Monkland Railways, which were taken over by the Edinburgh & Glasgow and became part of the North British in 1865.

The Approach to Waverley Station, Edinburgh.

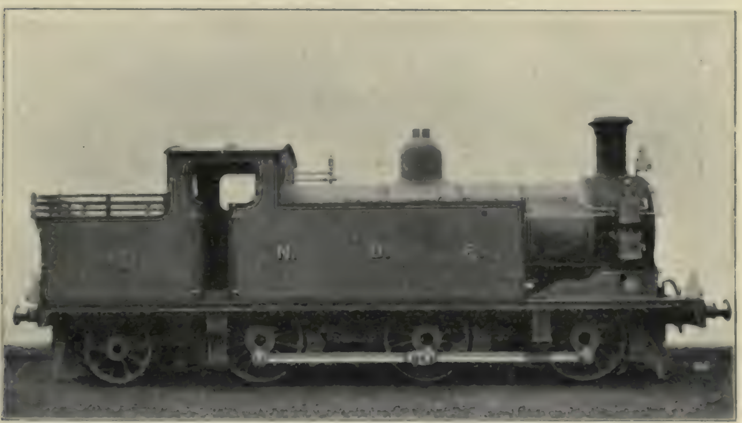
The Edinburgh & Dalkeith obtained its Act in the same year as the Ballochney, and opened in 1831, the engineer being James Jardine. It ran from St. Leonards to Dalhousie with branches to Dalkeith, South Leith, and Fisherrow. Part of it—from St. Leonards to Duddingston—was worked by rope and stationary engine, and there were no locomotives on the remainder until it became the property of the North British in 1845, as was evident from the notice-board allowed to remain at every station forbidding drivers to stop by the way to feed their horses.

The Fisherrow branch was the Innocent Railway of Robert Chambers. "Nobody," says he, "is ever too late for the Innocent Railway. One day we had started from Fisherrow up the inclined plane, when a washerwoman, with a huge bundle of clothes upon her back, was seen making after us on the line, occasionally waving a hand in the hope of its prevailing upon the conductor to stop. We thought the poor woman had no sort of chance of making out her passage; but, wonderful to say, she overtook us, burden and all, at a place where a short pause is made a mile and a half forward. There is a second stoppage—quite leisurely—at the bottom, to detach the rope, and yoke the horses to their respective carriages. Off they go, trotting at a brisk pace past Duddingston Loch; but we have not advanced above a quarter of a mile, when a lady with a parasol and ten bandboxes is seen waiting for us at a cross-road; and there is, of course, a pause to get her taken in. This accomplished, on we go again; but lo, ere we have gone another mile, we have to stop at another cross-road to let off a farmer. Once more in motion, we advance rather briskly—that is, at the rate of about eight miles an hour—in order to make up for lost time; but this has not lasted half a mile, when we meet the carriages proceeding to town, and have to stop, in order that the drivers may pass some message in the one or the other direction. A few more minutes brings us into the station at Fisherrow. The passengers land in a place like a farm-yard,

No. 898 Express Passenger Engine "Sir Walter Scott."

where ducks and hens, and a lounging dog, and a cottager's children, are quietly going about their usual avocations, as if undreaming that they are within fifty miles of such a thing as machinery. Just conceive a railway where the carriages have barefooted boys to come off and run on in advance to change the switches!"

The South Leith, the Dalkeith and the Fisherrow branch are still used, having been altered and adapted at an early date, and in 1845 the projected line to Hawick was taken over by the North British, which picked up the Dalkeith on its way to cross the Border, for like the Caledonian it comes south of the Tweed. Nearly a quarter of its Waverley route is in England, and from Riccarton it reaches Morpeth to the east, and Silloth on the Cumberland coast, and Hexham half-way between.



Tank Engine No. 863—for Local Traffic.

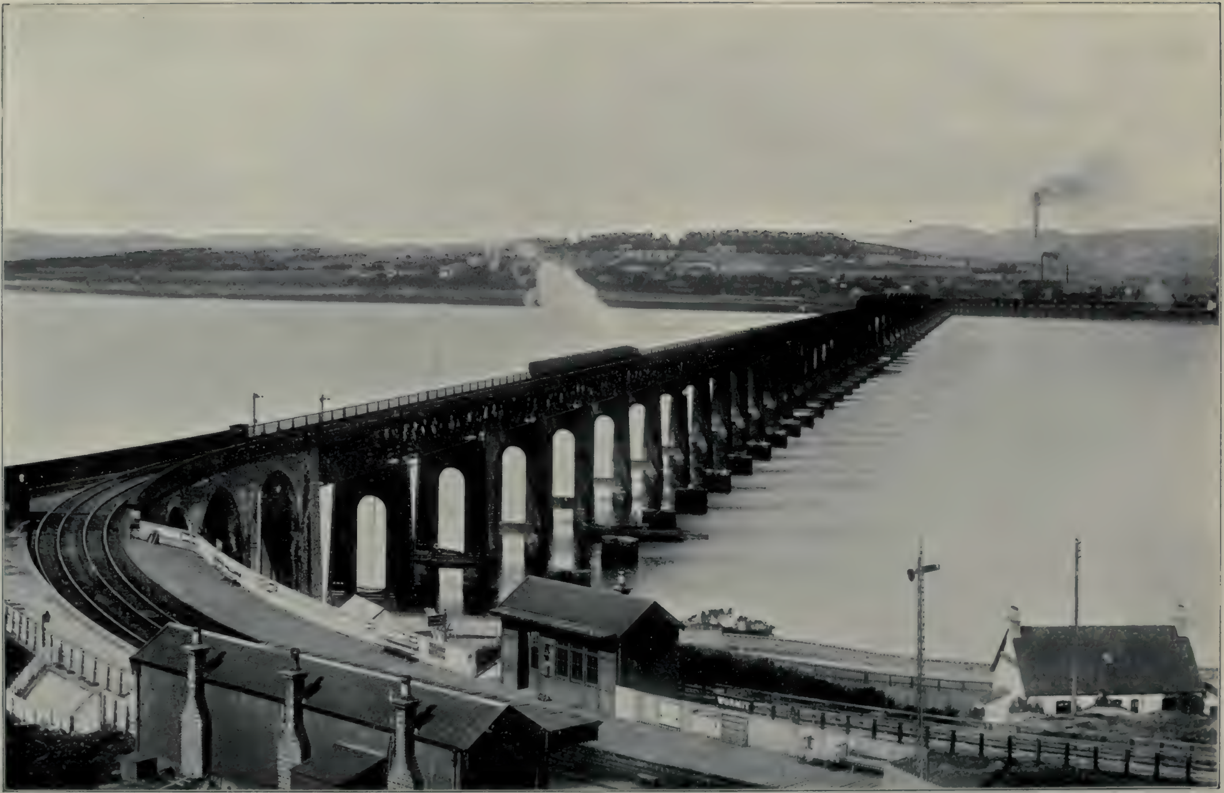
The next old company that should be noticed is the Edinburgh, Leith & Granton, opened in 1842, six years after it was authorised. This was absorbed by the Edinburgh & Northern, and put Edinburgh in communication with Perth and Dundee, or rather Tayport, which meant the same thing, and it was generally known as the Edinburgh

& Dundee until it became North British in 1862. If we add to this the Edinburgh & Glasgow, authorised in 1838 and opened in 1842, which the North British acquired in 1865, we shall have said enough for our purpose with regard to these old lines.

Now the North British extends to Bervie on the east coast and Mallaig on the west, and its farthest north is Fort Augustus, which it reaches through the long West Highland line from Craigendoran opposite Greenock on the Clyde. Its multitudinous loops and branches need not be particularised ; suffice it to say that it has about seventy terminal stations and a length of some 1350 miles, of which over 800 are single line. It carries 38 millions of passengers a year, 22 million tons of minerals, and 5 million tons of merchandise ; its coaches and wagons exceed 71,000 in number, and it has nearly 900 engines, whose yearly mileage totals up to considerably more than 18 millions. It owns 50 acres of docks, at Silloth, Bo'ness, Alloa, Charlestown, Methil, and Burntisland ; and from each of the last two it is shipping 12,000 tons of coal a day. In short, it is the largest Scottish railway though not the most profitable, its capital being £66,000,000, a fifth greater than that of the Caledonian.

In Waverley it has the largest station at present in the country. This covers 23 acres, half of which are under glass, and the length of the platforms is close on 2¾ miles —a fine station, well planned, but to a great extent hidden away, its height and roofing hampered by the respect that had to be paid to ancient lights. There are two ways to it from the south, that by the East Coast and the so-called Waverley route from Carlisle.

The road from Berwick is not difficult. From Berwick, along by the cliffs, it rises for five miles past Lamberton, crossing the Border at 1 in 190 ; then comes a level stretch for four miles, then a rise up the Eye Water at 1 in 200 to Grant's House, the highest point. For five miles onwards



THE NEW TAY BRIDGE

it falls at 1 in 96, continuing by easy undulations until it runs up into Edinburgh at 1 in 78.

The Carlisle road is of a more arduous character. Undulating gently for eleven miles it begins to rise for eight, four of which are at 1 in 100, and then it falls for two miles to cross the Border at Kershopefoot. Rising from there it reaches 315 ft. a mile beyond Newcastleton, and then up it goes for eight miles at 1 in 75 to the summit, 955 ft., thirty-four miles from Carlisle. The descent for eleven miles to Hawick is at 1 in 75 and 1 in 100, and along the Teviot it rises for six miles to fall a similar distance to St. Boswells at from 1 in 120 to 1 in 200. Galashiels is reached by gentle slopes, and then begins an ascent by the banks of the Gala Water to Falahill, where the line goes over 850 ft. and descends for fifteen miles, eight of them at 1 in 70, to Portobello, whence after an easy stretch of a little over a mile it rises at 1 in 78 into Waverley on the same track as the other.

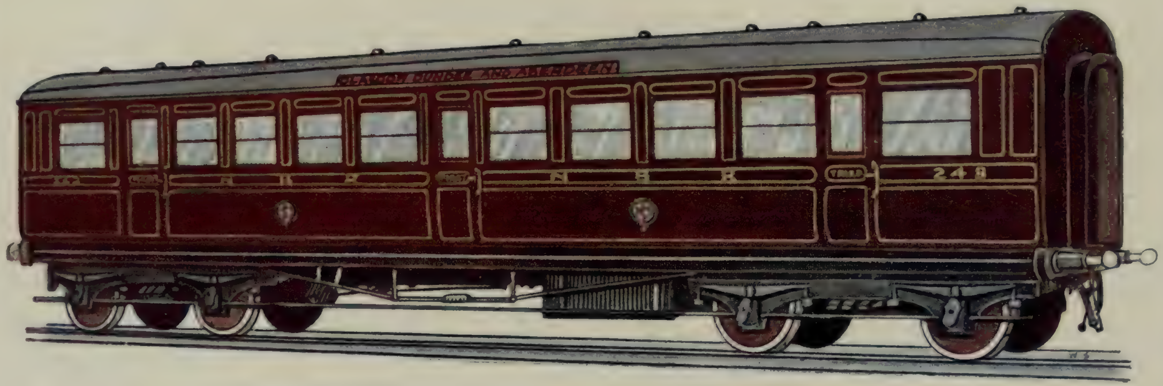
Tay Bridge Station.

The gradients on the Waverley route are not, however, the worst the North British passenger trains meet with. At Causewayend there is one at 1 in 23 for half a mile, and at Commonhead there is another of the same for a quarter of a mile, with one at 1 in 26 and another at 1 in 27. To say nothing of the old approach to Glasgow at 1 in 45, up which the trains were pulled by a rope, there are in Perthshire and out on the West Highland line several sharper than 1 in 75, including at least two of 1 in 53.

This West Highland line was, to put it mildly, a much discussed railway. That the North British should presume to come running down the north bank of the Clyde to Craigendoran and take a share of the boat traffic was simply horrifying to the Caledonian, but when it came to going north from there up the west coast to Mallaig and to Fort Augustus, as was evidently intended, the Highland joined in the fray, and the heat of opposition to " a project that could never pay " rose to a temperature quite inconceivable by those not engaged in it.

Northward this line goes to Garelochhead, then on, by the side of Loch Long, to Ardlui at the head of Loch Lomond, and up Glen Falloch to Crianlarich on the side of Ben More. Through the deer forests and on across the moor of Rannoch it continues, over the summit level of 1350 ft., to skirt the Treig and, passing the falls of Monessie, reach Spean Bridge in the Ben Nevis country, where it divides; the northern spur going by way of Invergarry to Fort Augustus, while the south-western takes you to Fort William, and from there westwards to Mallaig in North Morar at the entrance of Sleat Sound with Armadale in Skye across the water. One of the wildest, bleakest of routes, where the only two trains down and two trains up in the course of the day traverse the 122 miles from Arrochar at the rate of 24 miles an hour whenever they succeed in keeping time.

Before Waverley Station was enlarged it was the



THE NORTH BRITISH RAILWAY

COMPOSITE CORRIDOR CARRIAGE, No. 248

Extreme length . . 58′ 4″ Extreme width . . . 8′ 6″ Number of First-class compartments . 5.
Fitted with electric lighting. Vestibules, British standard. Third ,, ,, . 2.
Steam heated with individual regulators. Two lavatories with hot and cold water supply.
First-class compartments, trimmed in moquette, seating 4 each; third class, trimmed rep, seating 6 each.

standard excuse for the complaint that the North British was most remarkable for its unpunctuality, but there were other reasons for this. The number of connections, mainly forced upon the company by the position of the two estuaries, those of the Forth and Tay, were unusually great. There were connections, for instance, with both the East Coast and Midland routes to England from the west and north of Scotland, those from the latter being most uncertain, especially in stormy weather, while the working of the Forth and Tay ferries at all times constituted the chief difficulty in maintaining punctuality.

The "Flying Scotsman" passing Dunbar at 60 miles an hour.

Another improvement, taking the line out of a tangle of many branches and devious loops, was the building of the bridges over the Forth and the Tay, which are the two great engineering works of the system. The first Tay Bridge was swept away with a train on it in a hurricane in December 1879. It was designed by Sir Thomas Bouch, who as a bridge-builder was unlucky. His bridge over the Esk at Montrose, another fine structure, failed owing to the bad foundation afforded by the back-sands, and much money was spent in building the new lattice girder erection there, opened in 1882.

His Tay Bridge, within a few yards of two miles in length, consisted of eighty-five spans, of which thirteen were over the fairway, two of them being of 227 ft. span and eleven of 245 ft. On these thirteen the line ran on the upper members of the girders, and on the others it was on the lower members; in the smaller piers there were four pillars in a group, in the larger piers there were six, and the pillars were in both cases a foot in diameter. It seemed safe enough. In September 1877 it was completed; in May 1878 it was passed by the Board of Trade; in June 1879 Queen Victoria crossed it on her way from Balmoral and knighted Bouch; and six months afterwards it fell, and pitched itself and the train into the Tay with the loss of some seventy lives.

While the Tay Bridge stood, Bouch was busy in completing his plans for a colossal suspension bridge over the Forth, with towers 600 ft. high on Inchgarvie, which came to nothing, for the disaster simply shattered his reputation, paralysed railway enterprise for a time, and led to the Forth Bridge Company promoting a Bill for the abandonment of their existing works. That there should be a bridge over the estuary, or a tunnel under it, such as that to Rosyth, proposed as far back as 1808, was, however, clearly necessary for the development of the East Coast service, and, after the Bill was deposited, the company was reconstituted at the last moment on three leading engineers reporting that notwithstanding the collapse of the Tay Bridge a suitable, durable structure could be built. And then a design was prepared on quite a different principle.

To carry out this scheme was beyond the means of the North British, though the working of the traffic was to be entrusted to them. So a joint financial arrangement was effected by which the North British guaranteed

30 per cent. of the cost, the Midland 32½ per cent., and the North Eastern and Great Northern jointly 37½ per cent.; and thus it came about that in 1882, the year after the Act was obtained for the new Tay Bridge, the Forth Bridge was authorised.

The three engineers on whose report the company was re-formed were W. H. Barlow and Thomas Elliot Harrison, Stephenson's assistant on the Newcastle High Level, and John Fowler, who had begun as Rastrick's assistant on the Brighton, and among many things built, in 1860, the first London railway bridge across the Thames, that from Battersea to Pimlico; and it was Fowler, and his partner Benjamin Baker, who designed the bridge on the cantilever principle that had never been adopted before on anything like the scale.

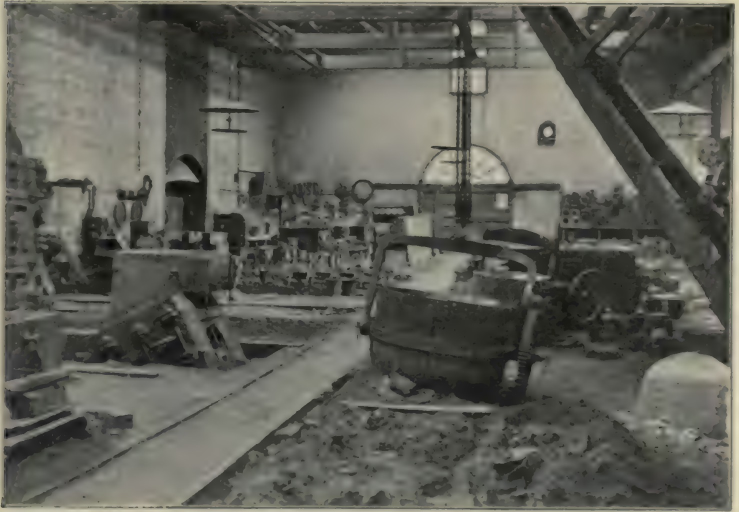
Berwick Station.

The stupendous structure, so well proportioned that it looks nothing like its size, really supports itself from summit to base at every point it touches the ground, and its dimensions and construction, with the horizontal truncated triangles of its roadway, render it proof against any hurricane that may rage. The principle is that of a pair of brackets placed back to back which balance each other and are anchored at their extremities; and the tubes of these brackets are 12 ft. in diameter, the piers that carry them tapering from 70 ft. in diameter at the base to 49 ft. at the top.

The Miscellaneous Foundry at Cowlairs.

Whenever a train comes on to the bridge there is a pull along the top of the bracket and along all the radii hanging downwards, and a thrust along the bottom of the bracket and on all the radii pointing upwards; and where there is a pull a lattice girder is used, and where there is a thrust a tube is used. Consequently all the main lines of the structure that spread from the top are girders and all that diverge from the base are tubes; and it is only when you pass underneath that you see how each tube is about the size of one of the columns that hold up an ordinary railway bridge.

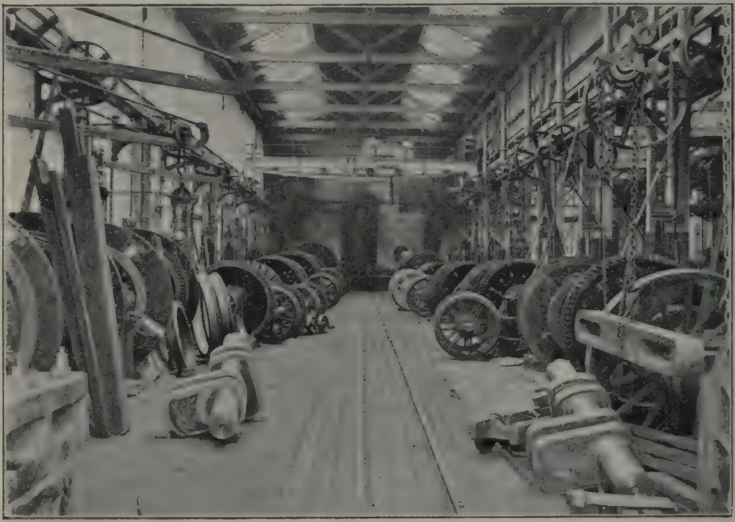
The eleven masonry arches account for 521 ft. of its length; and then there are eleven girder spans each of 168 ft., two of 173 ft., and two of 179 ft., ending at the masonry piers on each side which rise to 209 ft. above high water. Adjoining these are two single cantilever spans each of 689 ft. 9 in., followed by the two great cantilever spans of 1710 ft., each affording for the navigation a height of 150 ft. for 500 ft. of the distance between the piers.



The Heavy Foundry.

The tower on Inchgarvie is 260 ft. broad, and the towers on either side are 145 ft. broad. From the base of the deepest pier to the top of the tower above the height is that of the second pyramid of Egypt. Twice as high as the Newcastle High Level, it would stretch exactly from St. Paul's Cathedral to the York column in Waterloo Place; and the distance up lower Regent Street to the insurance office ending the vista is the same as the width of one of its spans. Stretching for over a mile and a half across the open water it looks a small thing, there being nothing near by to yield adequate comparison, though the dockyard at Rosyth may furnish something useful in that way.

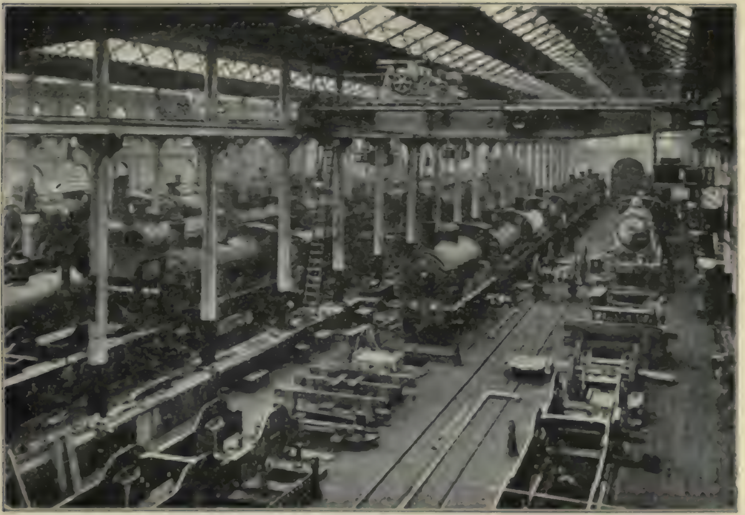
Unlike other bridges, which arrive more or less ready for erection, it was made on the spot, an extensive establishment being started for the purpose on the south side in 1882 by the builders, Tancred, Arrol, & Co.; and this was for years classed among the interesting industrial works of Edinburgh. The foundations began in January 1883, done by caisson in the usual way but on a giant scale, some of them going down 90 ft. below high-water mark. On the concrete came Arbroath stone faced with Aberdeen granite, and on the stone piers the massive bed-plates were laid and bolted, and smoothened with emery, and highly polished and coated with crude petroleum to keep them slippery under the skew-backs, which were



The Wheel Shop, Cowlairs.

fitted on with elliptical holes providing for expansion and contraction due to change of temperature.

The skew-back is the junction bed of the tubes; and in the structure there are six miles of tubes, and forty-two miles of plates were used to make them with. Each tube consists of ten plates and ten longitudinal beams, stiffened at each eight feet by a diaphragm; the plates vary from $1\frac{1}{8}$ in. to $1\frac{1}{4}$ in. in thickness, and are 16 ft. long by 4 ft. 4 in. wide, and they were squeezed into shape under a hydraulic pressure of 1600 tons between the dies.



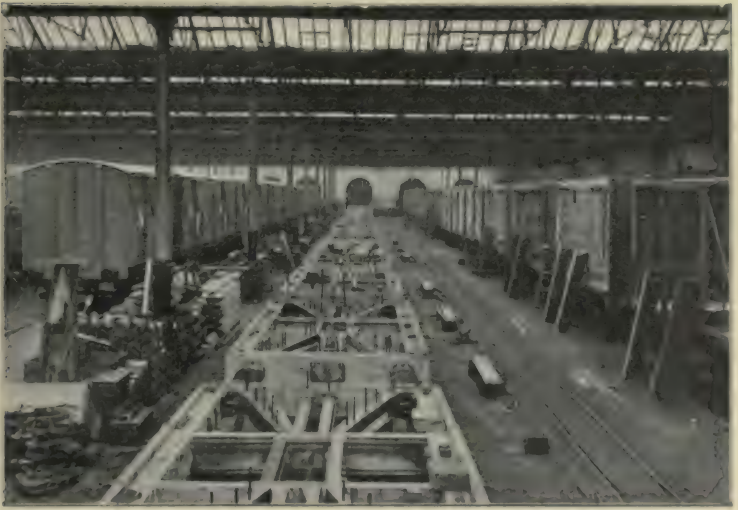
The Erecting Shop.

"Not only were the plates pressed," as was said by the writer at the time, "but they were planed and built up into position and had the rivet holes drilled before they left the shore. The scene at the yard can therefore be imagined. What with planing machines and dressing machines, and the circular saw cutting slabs of solid steel, and the hydraulic rams justifying plates and carving angle-irons, it would have been remarkable without the great drilling machines which were its chief feature. The tubes were built up on a mandrel just as if they were in position, but so large were they that instead of being taken to the workshop the workshop was brought to them, and travelled along them as they were constructed. This workshop had its own engine and boiler and its own system of drilling machines; and the travelling annular drill frames, each with ten drills kept cool by water jets, bored at a rate that would have sent the inch drills through 280 ft. of solid steel in twenty-four hours, and made holes at once through plate and cover and stiffener, so that when erected not a piece would be a hair's-breadth out of place."

Every appliance known up to then was used in its erection, telegraph, telephone, camera, tramway, wire lift, press, winch, and crane; and as the cantilevers were built out into space, one balancing the other and taking its sole support from it, with the cranes hanging over the outer ends and fishing up the material from the boats 300 ft. below, the 3500 men were almost invisible in the steel webs that rose in a line across the Forth. Night and day the work went on, even through midwinter, and in the night the webs stood out in brilliant light and dark shadow in the glare of the hundred arc lamps and hundreds of incandescents that provided an illumination such as had never been seen before.

Right and left, wider and wider grew the wilderness of work, as the zigzags went on lengthening until they joined up with the zigzags that stretched out northwards and southwards to meet them from the Queensferries. And then there came the painting—135 acres of it—and the clinching of the last rivet in the 52,250 tons of Siemens steel that completed the road along the mile of cantilevers which was opened on the 4th of March 1890.

The other great bridge of the line, the second one over the Tay, was designed by Barlow. It was opened in 1887, and is a few yards above the ruins of the first, a large, ordinary-looking, lattice-girder structure 3593 yards long, with a double line of rails running on the lower members of the girders over the fairway, and on the upper members elsewhere and not as in Bouch's design. Its long array of similar piers, looking at a distance like so many trestles, number no less than 87, the four over the fairway being 245 ft. apart and 77 ft. above the water. It is of no architectural distinction, and may be described as a monotonous erection redeemed from ugliness by its dimensions and the curve at the Dundee end.



Building Covered Wagons at Cowlairs.

In the very early days the North British locomotive works were at St. Margaret's, close to the Edinburgh terminus, where in 1863 there was built the then fastest engine on the line, best known perhaps as No. 1009, practically a Jenny Lind, 2–4–2, with 6-ft. drivers, no dome but a brass casing to the safety valve, the boiler being 10 ft.

4 in. by 4 ft. and the working pressure 130. Such was the type that drew the East Coast expresses in the early sixties.

When the Edinburgh & Glasgow—with its arms and all complete—was taken over, the works were transferred to Cowlairs, where they now are. The oldest engines were, however, those of the Monkland, which was not absorbed until afterwards, the passenger stock that then became North British being 0–4–2's with 5-ft. drivers and 3 ft. 6 in. trailers. In appearance they were far inferior to the seven Edinburgh & Glasgow specimens, which were as smart as Great Westerns with their green bodies, brass domes, and brass edgings and rails. These old brass-bounds, numbered finally from 233 to 239, were a thoroughly honest sort all the same, and kept going noisily and happily for forty years or more.

Another well-known lot were the 6-coupled goods built by Mr. Wheatley, who was at Cowlairs between 1869 and 1874. These had 4 ft. and 5 ft. wheels, and cylinders 16 in. by 24 in. and 17 in. by 24 in., and underwent a considerable change in their later days, Mr. Dugald Drummond having altered some of them into saddle-tanks, and Mr. Matthew Holmes having rebuilt others with improvements. They have been long outclassed, for they were a feeble folk compared, say, with No. 329, with her 18½ in. by 26 in. cylinders and 1794 sq. ft. of heating surface.

Soon after the Waverley route was opened in May 1876 Mr. Drummond came out with a class of 4–4–0's having 18 in. by 26 in. cylinders, wheels 6 ft. 6 in. and 3 ft. 6 in., boilers 10 ft. 3½ in. by 4 ft. 5⅛ in. having 201 tubes and a heating surface of 978·29, to which the firebox added 102·67, so as to make the total 1080·96, the grate area being 21 and the pressure 150. Those were the days of the quick, hot luncheon at Normanton, which was excellently done when you entered into the spirit of the thing and gave the waiter a chance, while to those who did not the courses were all removes; and the laggards being in the majority the dining-cars came on to add tons to the train. So to keep the speed up these engines were rebuilt with 18¼ in. by 26 in. cylinders, the boiler diameter increased to 4 ft. 7 in., the tubes by 32, thus increasing the heating surface to 1224, and the firebox being enlarged to 126 the total heating area became 1350, and at the same time the working pressure was increased to 175. Heavier trains requiring still more power a new class gradually replaced these with cylinders 19 in. by 26 in., a heating surface of 1577 made up of 1444 and 133, the grate area being 22·5.

Kinnaber. The Junction of the East Coast and West Coast Routes to Aberdeen.

When the Forth Bridge was opened the engine that drew the first train was No. 602, a 7-ft. 4-coupled with 18 in. by 26 in. cylinders, of the same class as No. 592, with which Mr. Matthew Holmes took the gold medal at the Edinburgh Exhibition of 1886. Another class much resembling it was that named after No. 633, which had cylinders of the same size but 6 ft. 6 in. wheels.

To open the West Highland, good hill-climbers were evidently necessary to take trains up to Tulloch, and for it Mr. Holmes provided a small class with 5 ft. 7 in. driving wheels, a tube heating surface of 1130·41, the total with that of the firebox being 1235·13; of these, which worked at a pressure of 150, the weight was 43 tons 6 cwt., a third of it being on the driving axle. To haul the main line expresses a more powerful engine was designed in No. 729. This, a 4–4–0 like the rest, had the cylinders 18¼ in. by 26 in., the bogie wheels were 3 ft. 6 in., the drivers 6 ft. 6 in., the heating surface was 1350 sq. ft., of which 1224 came from the 254 1¾-in. tubes; the grate area was 20 sq. ft., and the working pressure 175 lb. These engines weighed 47 tons, the tender, with its 3500 gallons, weighing 39. Still the heating surface increased; in No. 317 it reached 1577 sq. ft. and the cylinders had become 19 in. in diameter; and now we have Mr. Reid's portly Atlantics, in which they are 20 in. by 28 in. and the heating surface is 2256.

When these tremendous engines are running with the steam shut off and the regulator closed, a jet of steam enters the cylinders and sprays oil into them from an oil cup connected with the automatic relief valve; and there are other ingenuities about them of interest to engineers. They have, of course, the North British bogie without a swinging centre but with inverted laminate springs and floating beams, the trailing boxes having a sliding cover on which the springs bear and underneath which the box is allowed the side play that enables the engine to suit itself to the curve. The cylinders are not horizontal but set at a slope of 1 in 48; the bogie wheels are 3 ft. 6 in., the coupled four are 6 ft. 9 in., and the trailers 4 ft. 3 in.; the centre line of the boiler is 8 ft. 11 in. above the rails; there are 257 tubes of steel with a diameter of 2 in. except at the smokebox end, where they increase by an eighth of an inch, the heating surface they yield being 2071·4 sq. ft., that of the firebox 184·8; the grate area is 28·7 and the working pressure 200 lb. Over buffers, engine and tender measure 63 ft.; the engine weighs 74 tons 8 cwt., the tender, with its 4240 gallons of water and 7 tons of coal, weighs 45 tons 8 cwt., the combined weight being 119 tons 16 cwt.—a nice little load for the permanent way of their own and other lines.

More recent are the Waverley class of 4–4–0's, represented herein by the Sir Walter Scott. These have 19 by 26 cylinders, coupled wheels of 6 ft. 6 in., a heating surface of 1618·12 sq. ft., a grate area of 21 sq. ft., and are worked at a pressure of 190, the weight of the engine being 54 tons 16 cwt., and that of the tender 46 tons.

The North British is a complicated system to manage, as can be seen from Bradshaw, where it occupies about 35 pages with no less than 57 different time-tables; and it has not only its own track to work its trains on but nearly 120 miles of other people's. Under running powers it traverses over 82 miles of the Caledonian, the longest stretch being that from Kinnaber, the next being the 20 miles between St. Vigeans and Kirriemuir; and on the North Eastern it has running powers over 26 miles, besides appearing on the Glasgow & South Western, the Midland, and the London & North Western. It gets from Larbert to Kilsyth on a joint line with the Caledonian, and, on another joint line with the same company from Dundee to Arbroath, it reaches Hillside, the northernmost station of its own on the Aberdeen route, the other branch from Montrose taking it farther north to Bervie on the coast.

This Dundee & Arbroath line is interesting from its vicissitudes. Its Act was obtained so long ago as 1836, and it opened from Arbroath to Craigie two years afterwards, reaching Dundee on the 1st of April 1840. It was laid in the old way, much of it on stone blocks—which had to be altered. Like the Arbroath & Forfar, it was of 5 ft. 6 in. gauge, under the idea that, as "it was not likely to be linked up with any long chain of communication," there was no harm in being experimental—and that had to be altered. The engines were, as usual with these wide gauges, expected to be more powerful owing to the extra width; and, as usual, owing to the patterns and tools, they were just the same as others with the space wasted by using inside frames and bearings. Though they might waste space, the company did not like to waste steam, and therefore the exhaust was led into the tender-tank to warm the water—and that had to be altered.

For some reason it was worked as a right-handed line—and that had to be altered. It started as an isolated concern, but before it was complete it ended its separate existence by being handed over on lease, with the Dundee & Newtyle, to the Dundee & Perth. Then the combined railways became leased to the Caledonian until 1850, when it slipped out of the agreement and became independent. After twelve years of independence it amalgamated with the Scottish North Eastern, which in its turn was absorbed by the Caledonian. Twice Caledonian, one would have thought it would have remained so; but no, for in 1880, owing to the higgling about the Tay Bridge, it passed into the joint ownership of the Caledonian and North British, to be managed by a committee of its own at Dundee, and form a section of the great north road on which the best of work is done.

An old line was not necessarily a flat line, as witness the just-mentioned Dundee & Newtyle which, among other strange experiences, underwent the ignominy of being advertised to be let, the advertisement ending with the remarkable announcement, "The proprietors do not engage to accept the lowest offer." It began boldly with half a mile on a rising gradient of 1 in 10, which it need hardly be said their lordships of Airlie and Wharncliffe, for all their bogies, did not work, for a rope was used as on the two other inclines.

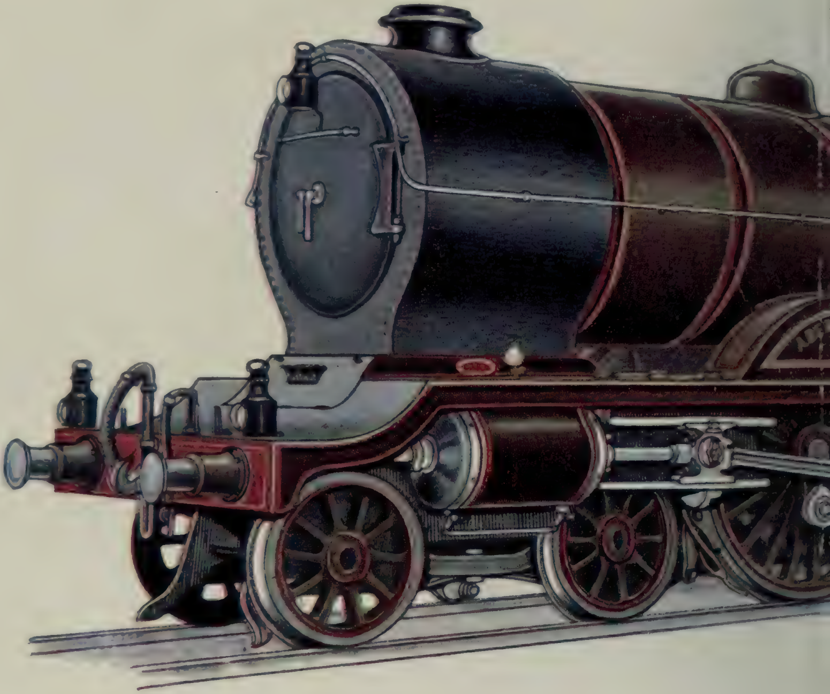
The rope was invaluable to the old engineers for getting up or down to an average level at which the rest of the line could be run. We saw it at Liverpool and at Euston; for many years it was used at Glasgow; but at Edinburgh it was not necessary, as the terminus was in the valley of the North Loch, on the eastern side of Old Waverley Bridge that took the place of the Little Mound. There, between the Edinburgh & Glasgow and Princes Street, but at the end of a rope, was the Edinburgh, Perth, & Dundee, and on the other side was the North British now

At Roy Bridge. Obtaining Moving Pictures for the Bioscope.

representing the three. At Cowlairs the rope was used for two years, then for some four years specially designed engines did the work, but these were taken off and the rope reverted to until November 1908. Barring the Cowlairs gradient—which is now avoided by the Low Level—the North British, in that old line, has the shortest and easiest route to the Clyde district.

Leaving Waverley you pass through the tunnel to Haymarket, where the Edinburgh & Glasgow ended when it opened, and on by Winchburgh to Linlithgow, thence to Falkirk, and so to Queen Street, where by the City & District you pass under Glasgow to the stations on the north bank of the Clyde as far as Craigendoran, for the coast steamers or the West Highland, or at Dalreoch, just beyond Dumbarton, you run off to Balloch on the shore of Loch Lomond. Thence the steamers take you right up to Ardlui, one of the loveliest, and cheapest, trips discoverable, or land you at Inversnaid, whence the coach will put you on Loch Katrine for the Trossachs, on the circular tour system that Scotland works to perfection and seems to have begun.

Craigendoran Pier.

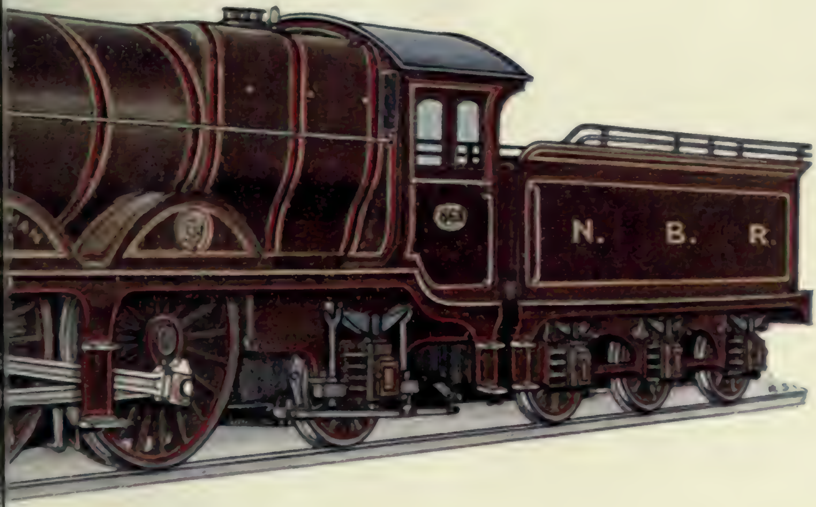


THE NORTH B

EXPRESS PASSENGER

Designed by Mr. W.

Boiler	Length	15′ 0″	Fire Box	Length	9′ 0″
	Diameter	5′ 6″		Width	4′ 0¾″
Cylinders	Diameter	1′ 8″	Heating Surface	Tubes	2071·4 sq. ft.
	Stroke	2′ 4″		Fire box	184·8 ,,
Tubes	No.	257			



TISH RAILWAY

OCOMOTIVE, No. 868

REID, M.INST.M.E.

DIAMETER	Bogie	3′ 6″
F WHEELS	Coupled	6′ 9″
	Trailing	4′ 3″

RATE AREA . . . . . . 28·5 sq. ft.

VORKING RESSURE 200 lb. per sq. inch.

		Tons.	Cwt.
WEIGHT IN WORKING ORDER	Engine . .	74	8
	Tender . .	45	8
	Total . . Tons	119	16

WATER CAPACITY . . . 4240 galls.

COAL CAPACITY . . . . . 7 tons.

Express crossing the Fiddich Viaduct at Dufftown.

THE GREAT NORTH OF SCOTLAND

THE Great North of Scotland began with an attempt to make a line from Aberdeen to Inverness, but it has not got there yet, its trains from Elgin to Inverness running on the track of the Highland Railway. And in the same year, 1846, extensions were authorised to Fraserburgh, Peterhead, and Aboyne. Not until 1852, however, was the main line begun, the first sod being cut at West Hall, near Oyne, in the centre of Aberdeenshire; two years afterwards it was opened to Huntly, and in 1856 it reached Keith. In 1852 another company, the Deeside, obtained an Act, and in 1857 completed the line through Banchory to Aboyne. For more than thirty years this, with about half a dozen other local ventures, has been amalgamated with the Great North, and it forms the southernmost of its branches, and has been extended as far west as Ballater.

From Keith the line went to Craigellachie, whence it reaches Elgin and Lossiemouth to the north, and Boat of Garten to the south-west. Fill in this corner of Scotland

16 in. by 24 in. to 18 in. by 26 in., and the heating surface from 756 tc 1297. The driving wheels have varied between 4 ft. 6 in. and 6 ft. 1 in., and the weight in some cases has become nearly half as much again. In the early days the springs were fitted with the equalising lever, and in Mr. Manson's 1888 design the tender instead of having side buffers was coupled to the engine by a central bar and rolling block—a plan more appreciated in America than in this country, where, in order to allow of as little play as possible between engine and tender, the side buffers are kept fairly well compressed.

It is remarkable that the ends of an engine are so seldom mentioned. Nowhere is the complicated structure of the wonderful machine more clearly indicated than on the footplate, but few are the references to the array of levers and gauges that enginemen have to manipulate; and some reference to the matter may not be out of place here, though attention can be directed only to the more important items.

The regulator is easily distinguished, though it has altered much in shape. To the right of it, as you stand on the footplate, is the vacuum pressure-gauge, with the boiler pressure-gauge corresponding to it on the other side. Between the two, and above the regulator, is the gauge lamp with the two whistles above it. Below the regulator, in the centre, is the water-gauge lamp, with the water-gauges right and left, the gauge no longer an unprotected tube but encased in a toughened glass box, the heights being indicated, in the Hulburd pattern, by diagonal slits cut in a white enamelled plate so that they are magnified by the water in the tube and look quite small and indistinct above the water-line.

Right and left of the water-gauges are the wheels of the combination injectors, and above, to the right of the right-hand one, come in due order the steam brake handle with the three-way cock some distance below it, the steam

ELGIN STATION

valve to the ejector with the steam valve for the small ejector below it, and then the vacuum brake valve handle, while the powerful reversing screw is unmistakable alongside it, the lever in the corner working the cylinder cocks.

Above the left-hand injector are the coal-watering cock and the blower cock, the latter near the regulator; below the wheel are the overflow cock from the injector on the left and the feed cock on the right. Close to the fire-door screen on this side is the back damper handle, the front one being farther to the left, and almost on the floor is the water-cock from the feed-pipe to the ash-pan. Right and left on the floor are the sand-boxes; above the left-hand one is the trailing sand-box lever, the leading one being higher up. Farther up in the corner, level with the injector controls, is the sight-feed lubricator. We may have left out something, but altogether here is a nice lot of tools for two men to see to when the engine is in speed.

With regard to the front of an engine, the most interesting things are the lamps, now much simplified by the Clearing House Code, of which an illustration appears herein. The disks are too numerous and varied to be dealt with except in detail, and the subject would require a long illustrated chapter devoted entirely to it.

The annual mileage of the Great North engines approaches 2¼ millions, of which 1½ millions represent its passenger traffic. Its goods traffic, besides cattle and sheep, consists largely of fish, as might be supposed from the number of fishing ports, large and small, with which it communicates round the coast; and its revenue decreases when the whisky trade is depressed, owing to the distilling industry being so important in the districts it serves.

As already mentioned, it is almost entirely a single line. Few are aware that of the 20,000 miles of this island's railways 7500 are single track. Our railways are not all double lines of 4 ft. 8½ in. gauge; just as there are one, two, three or more tracks in some instances, so there are no less than ten different gauges, ranging from the standard down to 1 ft. 11½ in., of which there are no less than 63 miles; and the almost equally important loading gauge seems to range through every inch between 9 ft. 6 in. and 13 ft. 9 in. On the Great North it is 12 ft. 11 in.

The iron templates that show the loading gauges are seen hanging up across the siding at many stations. Not only has the middle height above the rails to be taken into consideration, but owing to the shape of the arched bridges and tunnels the height at the side and also the width have to be reckoned with. It does not do to run too close to the span of the gauge, as witness the story of the pantechnicon furniture van that cleared all the bridges going out loaded, and could only be brought back by a roundabout route when empty because the weight having been taken off the springs it was an inch higher at the shoulder. That was not on the Great North, for the

The Bridge over the Spey at Fochabers.

springing of its lowest arch is 11 ft. 3 in. from the rail, thus giving its rolling stock a larger load margin than any other Scottish railway.

In 1856 its Aberdeen station was at Waterloo, that of the Aberdeen Railway (absorbed by the Caledonian in 1866) being at Guild Street, and between the stations was nearly half a mile of crowded quays. To fill the gap between Aberdeen and Kittybrewster the Denburn Valley line was made at a cost of £190,000, and Waterloo was left with the goods, the passenger work being transferred to the new joint station that inside is so very like the old Brighton at Victoria, the roof being almost exactly the same. Into it come not only the Caledonian but the North British, whose running powers bring it in all the way from Kinnaber, which is farther from Aberdeen than Reading is from London.

Great North Express passing Loch Park, Drummuir.

Photo, D. Whyte, Inverness.]

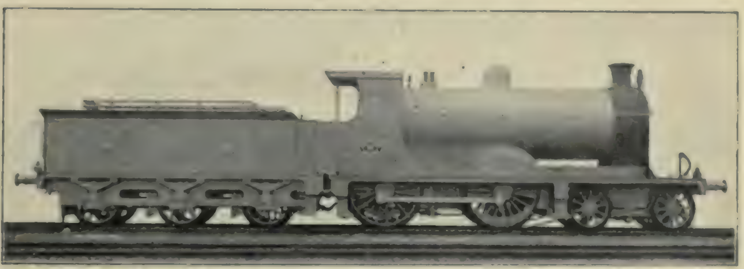
Inverness Station.

THE HIGHLAND

The Highland Railway does not reach Perth, as generally supposed, but comes as far south as Stanley Junction, within eight miles of it, the intervening line belonging to the Caledonian; and it runs right away up to Thurso on the Pentland Firth, or rather at its western entrance. To the east from Inverness it reaches Portessie on the Moray Firth, and on the west it ends at Kyle of Lochalsh opposite Skye.

Railway cartographers—that seems to be the correct term—nearly always manage to make their main line look straighter than that of their competitors and fill in the details to fit, but the Highland, perhaps because it has no competitor for the most part, or that the attempt was hopeless, gives the line just as it is, a most meandering route to the far north. For the sinuous course, however, there are two good reasons, one the difficulty of dealing with mountain and valley, the other the policy of the projectors, who in a commendable spirit thought less of the dividend than of the development of the country.

And so, like the outline of a dissected puzzle, it swings westward to Dalnaspidal, eastward to Aviemore, westward to Beauly, eastward to Fearn, westward to Lairg, eastward to Golspie on the coast, then up the coast and westward to Forsinard and northward to Georgemas, our most northerly junction, where it branches south-eastward to Wick and north-westward to Thurso. From Stanley Junction to Thurso, as the crow flies, is 135½ miles; and by the Highland Railway it is just double as far.



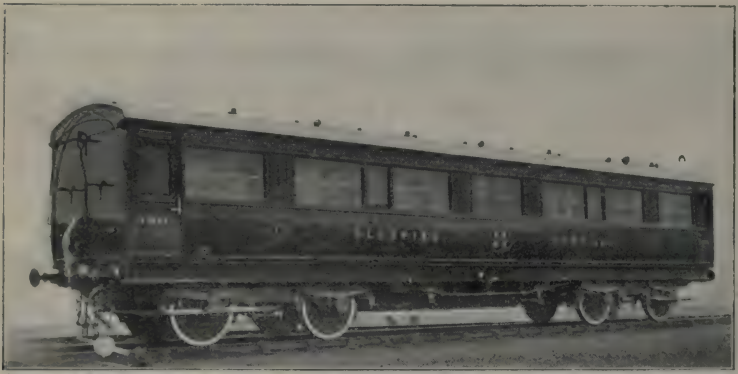
Photo, D. Whyte, Inverness.]

Express Passenger Engine No. 61, "Ben" Class.

It began with the Inverness & Nairn, fifteen miles long, which opened in November 1855, and became in 1861 the Inverness & Aberdeen Junction by amalgamation with the then three-year-old line from Nairn to Keith. In 1863 the Perth & Dunkeld, opened in 1856, was absorbed, as was also its continuation the Inverness & Perth Junction, and in 1865 the amalgamated companies took the name of The Highland Railway.

Meanwhile the lines were being pushed northwards. The Ross-shire Railway, Inverness to Invergordon, was opened in 1863, and extended to Bonar Bridge in 1864; the Sutherland Railway from Bonar Bridge to Golspie was opened in 1868; the Dingwall & Skye, to Strome Ferry, was opened in 1870, and extended to Kyle of Lochalsh in

November 1897. In 1871 the Duke of Sutherland—"the real duke who drove his own engine on his own railroad and burnt his own coals"—made a railway from Golspie to Helmsdale, and the final stage in this direction was reached when the Sutherland & Caithness from Helmsdale to Wick and Thurso was opened in 1874. Within the next ten years all these were merged in the Highland, which grew by extension and absorption until it now has a length of 485 miles and 146 engines, with a united annual mileage of over 2,800,000.



Photo, D. Whyte, Inverness.]

Composite Corridor Sleeping Carriage No. 8.

The Highland has always had good engines, well kept and smart as though their drivers took a pride in them. There is no mistaking them in their green livery, without referring to their Gaelic names which look so alarming and sound so sonorous. The first locomotive superintendent was William Barclay; he, after ten years of office and an interval, was followed by William Stroudley, who came from Cowlairs, where he received the yellow inspiration he took on to the Brighton.

To him was due the invention of the snow-plough that fixed on the front of the engine with the cap of the chimney peeping over the top, for the Highland is much troubled by snowstorms and rough weather, and even doubles its chimneys, putting louvres in front of the outer casing to stop the blustering wind checking the draught through the fire.

Stroudley was succeeded by David Jones, who had been in the company's works from the beginning when it possessed but a couple of engines, five coaches (in good condition as they always have been), and just six-and-twenty wagons. His engines were mainly 4-coupleds, including the Strath class of 1892 and the more powerful Lochs of 1896. His 4–6–0's with 20 in. by 26 in. cylinders were the first of the type in the island, and for some time the most powerful main line engines on the rail.

Photo, D. Whyte, Inverness.]

The Highest Summit Level in Britain, 1484 ft. between Dalnaspidal and Dalwhinnie.

Though the passenger expresses between Perth and Inverness are drawn by the Castle class of 4–6–0's with cylinders 19 by 26, 5 ft. 9 in. wheels, and a heating surface of 2050, the 4–4–0 engine may be described as the dominant type of the line, the most recent designed by Mr. Peter Drummond continuing the tradition. The goods engines are also noteworthy, as, for example, those like No. 134, a 6-coupled with 5 ft. wheels and 18¼ in. by 26 in. cylinders, or No. 19, a 6-coupled with 5 ft. 0½ in. wheels and similar cylinders, with a heating surface of 1307 including that of the water-tubes in the firebox. There are also a few good shunting engines such as the 6-coupled tanks with 5 ft. 3 in. wheels, 18 in. by 24 in. cylinders, and a heating surface of 1179.

Photo, D. Whyte, Inverness.]

Bridges at Struan Station.

Just as the Beattock bank made the Caledonian engines good from the first, so have the curves and gradients of the Highland had their effect. Power had to be had, sometimes at both ends, as even in these days, to get the trains along its undulating track.

From Perth you go north through the picturesque to the desolate. Perth is a joint station belonging to the Caledonian, with the Highland and North British as junior partners, and it has long been proverbial for its exhibitions of rolling stock. Your train is the harlequin, so called from

A ROCK CUTTING, NEAR KYLE OF LOCHALSH

its being made up of patches of through coaches and vans from every line of importance, Scottish and otherwise.

Up through Perthshire you go with its beautiful woods and hillsides; past Dunkeld with its larches, the first planted in Scotland and that as far back as 1738; over Dalguise Bridge across the Tay; through Pitlochry and the Killiecrankie Pass, over a curving, ten-arched viaduct 40 ft. above the bed of the stream; then on over the Garry tossing along its rocky bed below you, and farther over the bridge likewise 40 ft. above a river, through the deep cutting to Dalnaspidal, climbing to the summit level, 1484 ft. above the sea, and descending swiftly to bleak Dalwhinnie. Kingussie is then reached, with the Grampians well behind you, and on you go through Aviemore, to cross the Findhorn by the steel bridge that carries you 145 ft. above it, and then the Nairn by the long red sandstone viaduct of 28 arches rising 135 ft. from the

Photo, D. Whyte, Inverness.]

A big Snow Block in the Highlands.

river, and so by Culloden Moor to Inverness the beautiful, the capital of the Highlands and the heart of the Highland, for there are its headquarters and its locomotive works.

From Aviemore the old roundabout route will take you past Boat of Garten, the western outpost of the Great North, and up by steep gradients to the Knock of Brae Moray and down again to Dava. Then you speed over the Divie Bridge, which, like so many of the other viaducts, begins and ends with battlemented towers, and down to Dunphail, and on to Forres through the mighty cutting and along the embankment that is just 77 ft. high. Farther north, if you would see the scenery of the west, the sternest and wildest of Caledonia, you go off the main line at Dingwall, and begin by climbing the Raven's Rock for four miles at 1 in 50 before you get really going on your way to Strome Ferry and beyond.

From Inverness on your northward way you continue going west for a time over the Ness Bridge and the swing bridge across the Caledonian canal, skirting the three firths—of Beauly, where you turn to the right, Cromarty and Dornoch—to Bonar Bridge, and up the romantic course of the Shin, by cutting and embankment, to that anglers' gathering place, Lairg, and then to the coast again, and along to Helmsdale with the Duke of Sutherland's private station—one of the five private stations in this island—at Dunrobin. Ascending the river you reach Kildonan of the gold diggings, and cross the country of the snow-drifts to Altnabreac, and so on to Georgemas. Wick, to the south-east, is fourteen miles away, and there you get the fishery world displayed, with herring-boats and other boats and accessories that never fail to be interesting. Seven miles north of Georgemas and nineteen miles from Wick lies Thurso, and in the corner between them is Duncansby Head with John o' Groat's. Such is the Highland Railway, the grandest route in Britain.

It has taken us to John o' Groat's, and we have traversed the length and breadth of the land from Cornwall to Caithness, and traced the development of the greatest industrial enterprise the world has seen. It is merely the story of "common carriers," but think of it!

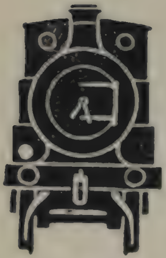
Just over a hundred years ago Richard Trevithick with his Catch-me-who-can was carrying the first passengers who paid a fare to ride behind a locomotive, and now, on our 39,000 miles of running track, 22,700 engines and 237,000 vehicles are carrying in a year 492,000,000 tons and a multitude approaching the number of the population of the globe. And a sovereign has been invested for every journey taken by a passenger in the course of the year—£1,300,000,000 at 3½ per cent.—that is the financial result of what our railwaymen have done; while another result, of importance to all who travel, is that no safer place is known to man than a seat in a carriage on any of our home railways.

Photo, D. Whyte, Inverness.]

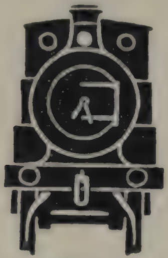
Station and Pier, Kyle of Lochalsh.

TRAIN LAMPS

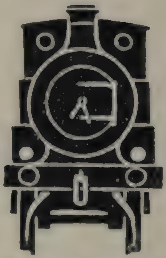
CLEARING HOUSE UNIVERSAL CODE



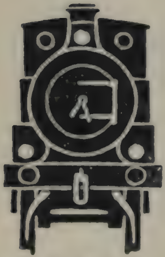
Light Engine.



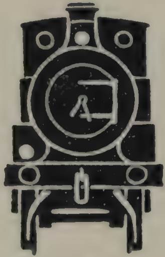
Stopping Passenger Train.



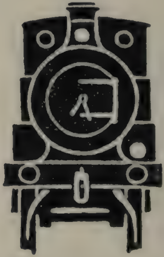
Express Passenger Train.



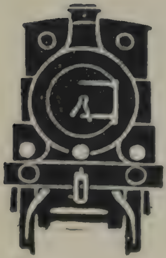
Empty Passenger Train.



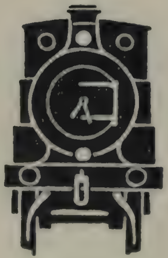
Express Fish or Meat Train.



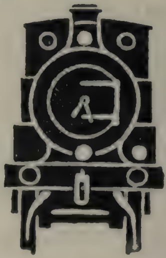
Express General Goods.



Through Goods or Mineral.



Cattle Train.



Stopping General Goods.

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